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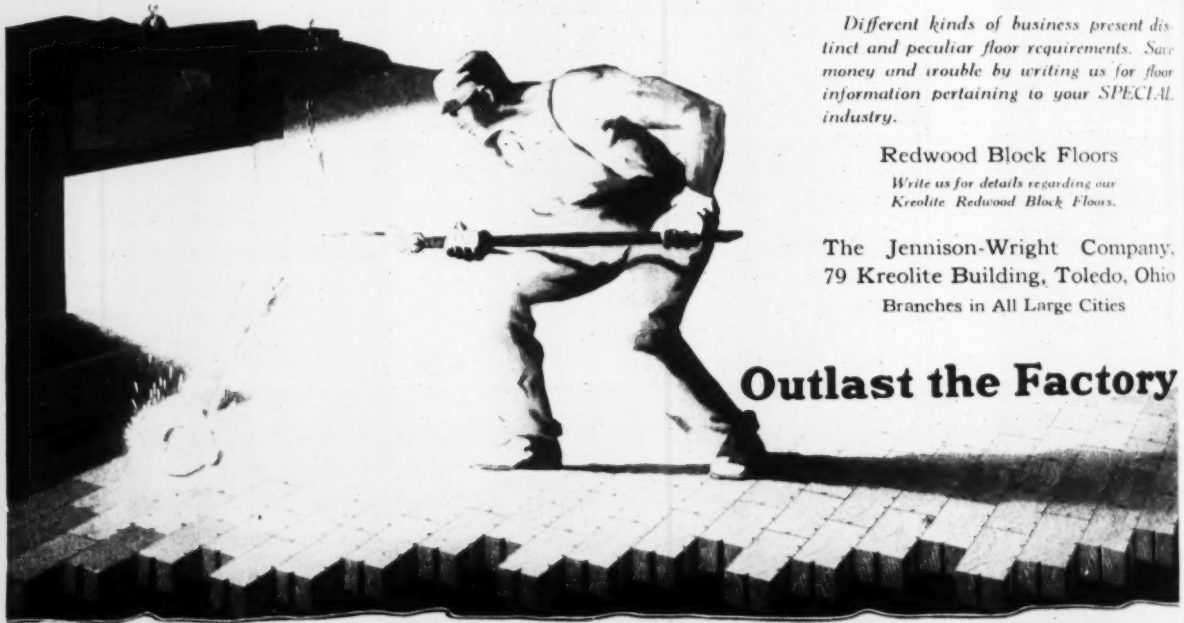

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. Mehren
Editor

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Indicting A Whole Industry

FOR the last two months the Department of Justice at Washington, with a keen sense of publicity, has been unfolding bit by bit its campaign against the conduct of the construction operations of the war. Public opinion is divided in its judgment of this campaign; to some it is merely partisan politics, the continuation of the congressional investigations to discredit the Wilson administration; others regard it as a proper showing up of profiteering which, through a popular misconception of the cost-plus contract and its consequences, is commonly thought to have been greatest in construction. The political strategy here exhibited may be only of academic interest to engineers and contractors, as such, but the direct charges of negligence, corruption and even treason against individual engineers and contractors implicate the whole construction industry and that industry cannot afford to shift the burden onto the shoulders of the men directly accused of misdoing.

Up to date the Attorney General's charges are in two parts; first, a series of suits to recover from the contractors on certain of the national cantonments sums totaling over $50,000,000 alleged to have been paid out by the government in excess of the fair and reasonable cost of those camps, due to the "fraud and deceit practiced" by the contractors, and second, a criminal indictment against seven men associated with the Emergency Construction Committee of the Council of National Defense for conspiracy to control the construction program of the war to their own benefit and the benefit of their friends, clients and prospective clients, thereby obstructing the war and defrauding the government—which comes about as near treason as any one not a lawyer would care to define it.

Obviously it is impossible here to specify all of the charges of the suits and of the indictments or to defend the accused by set phrase; that is their obligation when the cases come to trial. But it is possible briefly to reconstruct the scene of the operations which are denounced, to point out the controlling elements in the situation as it was in 1917 and to indicate the interest of the whole construction industry in the events which then occurred.

When war was declared on April 6, 1917, this country was not prepared; that is a matter of history. And in no way was it less prepared than in a definite policy as to the numbers of and means of raising an army. It was not until six weeks later that the national army by conscription was decided upon and not until well into June that it was appreciated that, by September, sixteen camps to house nearly a million men would have to be built. Here was a construction job unprecedented in magnitude and far beyond the capabilities of the regular army as then constituted.

Those who were in Washington at the time know what happened. The confusion in designing the camps and in devising contracts to build them became worse confounded. The Quartermaster Department—the existing agency for domestic camp construction—had certain designs evolved from the late Mexican campaign; these were changed overnight by advice of the allied military commissions then arriving in Washington and again the next night by advice of the Medical Corps. Three regular quartermaster officers were struggling with a construction problem of staggering proportions. The Corps of Engineers, already occupied with the stupendous job of preparing for the engineering conduct of the war in France, was seeking control of the camp construction, or if not seeking such control was a receptive candidate. And meanwhile no progress was being made toward building the camps.

At this juncture the Council of National Defense began to function. An extra-departmental body, legalized but of vaguely specified powers, it had attached to it a number of civilian advisors, among whom was a committee of engineers, architects and contractors, all experienced in large construction. This committee became associated with the General Staff in an advisory capacity, and from that association the so-called civilian control was born. It resulted in a civilian recruited Cantonment Division, a part of the army reporting directly to the Secretary of War, and the Emergency Construction Committee whose members are now being accused. All this, of course, was done by order of the Secretary of War.

It was immediately apparent that no existing form of army contract could be applied to this emergency work. There are those now, five years after the event, who claim this not to be a fact but they forget or ignore the conditions. No plans existed for these cities—to house 40,000 men each—on which a contractor could bid nor would any reputable contractor have gambled on his ability to guess at unit prices through a period when labor and material were being driven daily upward by the scarcity demand. Force account construction meant building up from the bottom a whole contracting organization, time for which did not exist, and probably also conscription of labor, which was a national policy the President evidently did not want to consider. The only way out seemed to be some form of fee or percentage payment to selected contractors who were competent and prepared with organizations to push through so gigantic a task. The formulation of such a contract was assumed, with the apparent acquiescence of the War Department, by the Council of National Defense. Its competent construction committee devised the so-called "cost plus limited fee" contract as the only way to get the camps built and the War Department approved it, at the same time imposing on the committee the duty of selecting the contractors to do the work, also subject to the approval of the department.

This was unprecedented procedure, but the war itself was unprecedented and to those who were trying to conduct it observance of precedent pointed only toward one thing—an enemy victory. For it must be remembered that even as these preparations were being made Ambassador Page was writing confidentially from London that in all probability the Allies had lost the war and the future was in our hands. Troops had to be housed by September.

In the procedure thus briefly outlined lies the source of the criminal indictments. The men who made up this committee, together with Benedict Crowell, then assistant secretary of war in charge of construction, are charged not only with urging the semi-civilian control of the war construction but of deliberately conceiving the scheme of getting control and putting it through to their own benefit and to the loss of the government. In other words, according to the charges, in two weeks in May a group of men, not before associated together, not only combined to perform these illegal acts but managed to make dupes of the General Staff of the Army and the Secretary of War.

It is inconceivable, however, that now even the most bureaucratic or politically minded official could urge the criminal prosecution of those responsible for this procedure merely because it broke precedent. The charges are that it also resulted in terrific and unnecessary waste and delay and undue profit to some individuals. And here is where the recovery suits come in. One difficulty in considering this immediately arises, that of defining "undue" and "unnecessary." There is no standard by which the proper limits of waste, delay and profit can be measured. There is, moreover, no way of telling whether any humanly possible system would have resulted in lower costs or less waste, though the experience of many years of construction makes it virtually certain that no system could have procured the finished camps sooner. The construction of those camps was the outstanding achievement of the war so far as speed was concerned and in the summer of 1917 speed was king.

Excessive contractor profits are charged, but these charges are for the most part generalities. The atmosphere of both complaints and indictment exudes profiteering; the text itself rarely specifies. *The fact is that the cost plus limited fee contract limited profits on large scale work more than did any other contract made in the war.* It was a cost-plus contract with a decreasing scale and a fixed maximum profit of $250,000, which made the contractors' fees on the cantonments fall below 2½ per cent gross and much lower when taxes were deducted. There are charges of other profits, from salaries, subcontracts, equipment rental, etc., but added altogether it is certain that in actual money received the contractor would make much more on a lump sum contract of similar size in normal times. And yet these same contractors are being sued for from $4,000,000 to $6,000,000, as much in some cases as the total value of their contract.

Wastes beyond all necessity are charged. These range all the way from deliberate destruction of material to encouragement of labor soldiering. Waste there was; it would be silly to deny it. It was tremendous, outrageous, universal. But war never is economical and this was war, just as much on the scrub flats of Long Island as in the forest of Argonne. Specific cases by the hundreds could be pointed out where a waste could have been avoided. Any one who could, at the time, have devised some system whereby the accumulation of those wastes could be avoided would have been the superman looked for in vain. Waste at such a time is a defect of human nature. Lump sum bids, could they have been obtained, would have saved much of the waste, *but the camps would never have been built.*

Favoritism is charged. There were only a limited number of contractors in the country capable of undertaking the work. Most of them were awarded contracts. All of them had friends somewhere among the groups responsible for the awards. The way to have avoided that would have been to put some ice-cream manufacturer from Honolulu in charge of construction. He would not have had friends in the construction industry.

The system which grew out of the confusion of those early days was not ideal. So few things in this world are. But it was a real attempt to solve a problem which had to be solved immediately. In looking back from these calmer days there appear many faults but they are the kind one sees from the light of hindsight. Even the much abused cost-plus contract, to which are justly laid many of the evils of waste and high cost, has rarely been competently criticized *for the emergency that then existed.* Publicly it has been defended by some of the leading men in the profession and this very defense has led to one of the most outrageous attacks in the indictment. One clause of the indictment reads:

> At Washington, D. C., in aid of inducing and procuring the continuance of the system of cost-plus contracts awarded without competitive bidding, said defendant Starrett about March 12, 1918, named and procured to be appointed by defendant Crowell as acting secretary of war, a committee, of which committee certain members were interested in such contracts and systems, ostensibly to investigate and report upon the merits of said plan or system, which committee assembled on March 14, 1918, and reported on March 15, 1918, by adopting substantially as their report extended written statements and arguments made to them by said defendant Starrett and one Richard C. Marshall, Jr., then at the head of the Construction Division of the army, to which report, as though it were a report of a thorough and impartial investigation, wide publicity was given.

Who were the men who thus connived at perpetuation of this treasonable contract?

The presidents of three national engineering societies—Arthur N. Talbot of the civils, Charles T. Main of the mechanicals and E. W. Rice of the electricals, and president John Lawrence Mauran of the American Institute of Architects, president F. L. Cranford of the General Contractors Association of New York, president R. G. Rhett of the Chamber of Commerce of the United States, John R. Alpine of the American Federation of Labor and Oscar A. Reum of the Building Construction Employers Association. Later Francis Blossom, of Sanderson & Porter, C. A. Morse, chief engineer of the Rock Island, and W. S. Davies, then president of the accountants national society, formed another committee which paid similar testimony to the applicability of the contract for the emergency, and is likewise attacked in the indictment.

Are these men who would defraud the government?

As to the charges of personal corruption alleged in the indictment, they remain to be proved. We are asked to believe that the men accused after a lifetime of honest and fair dealing turned thieves at a time when menace of national disaster aroused even in the meanest the highest of motives and purpose. Violation of statutes are cited in the indictment but as alleged they are mere technicalities carrying no conviction to any but the inquisitorial mind. Possibly these men are guilty of some infraction of rule or law but they are not of the breed of which criminal profiteers are made.

WE HAVE thus violated the usual rule not to discuss cases before the courts because we believe that these suits and indictments have implications far beyond the personal affair of those concerned. They affect the whole construction industry. The men accused are among the most prominent in that industry. Those unnamed who must have participated in the alleged benefits had those benefits accrued are equally prominent and more numerous. The large body of representative engineers who made up the Construction Division are at best made out to be the simple dupes of these arch criminals who sway cabinet officers and control general staffs. And lastly the consulting committees condemned as accomplices after the fact were some of them the accredited representatives of the professional societies and all of them the most respected of our associates. It is a monstrous charge of iniquity that has been made against the best men in the engineering and architectural professions and in the industry. But the indicted men, and even those not indicted but maligned, are caught in the meshes of the law, so far embodied in a few officials in Washington. There is no redress save in the courts and the courts are notoriously slow. Meanwhile, they are branded before the country according to the respective indictments as wasters and incompetents or as criminals. Their eventual clearing can never redress the damage that will have been done. The least that can be demanded, if there be sense of justice in the department of that name, is to bring these cases to early trial—particularly in view of the widespread belief that the indictments are for political effect and that there is no intention of bringing them before the courts.

More than a century ago Burke said he knew of no way of bringing an indictment against a whole country. The Attorney General of the United States is better informed; he has found a way to indict a whole industry.

An Engineering Ambassador

AT THE dinner last week of the American Engineering Council some four score American engineers had the unique pleasure of listening to the first speech ever delivered by a foreign ambassador who is by profession an engineer. Prince Caetani, the diplomatic representative of the new Fascisti government in Italy, belied neither his training nor his present calling in his clear expression of the place the engineer plays or should play in international comity. The expedition now moving across the Franco-German border into the industrial heart of Germany is a plain token of what engineering means in the relations of nations. Is there any doubt that those relations would be better understood if discussed from the engineering viewpoint by engineers who in spite of difference of tongue talk the same language? That is the lesson the Italian ambassador sought to teach in his maiden speech. May he be but the first of a long line.

Defining Activated Sludge Anew

TWO schools have risen championing two principal theories as to the how and why of activated-sludge action. One holds that biological or living organisms do the work while the other claims much for chemistry and physics, mainly through colloids. Dr. Buswell, on p. 119, from comparatively simple tests together with the reasoning from previous investigations propounds a new statement which in a way is a combination of the biological and colloidal theories. Much as garbage disposal is handled by feeding to hogs so the organisms—no one variety—ingest, digest and assimilate organic matter in sewage into the living material of the "synthetic gelatinous matrix" in which bacteria are imbedded and on which larger forms of life crawl and feed. The organisms use chemistry in the digestive process and perhaps in the ingestive process. This synthetic biological attribute of sludge seems to be logical. Dr. Buswell's quantity measure of the surface by the Sedgwick-Rafter biological tests long in use is novel but nevertheless affords a real yardstick, and it is yardsticks we need to evaluate the various factors in the sludge "digestion" operation. Knowing how much surface will handle a given quantity of sewage throws the problem into the realm of practice, for we arrive then at the conclusion that in activated-siudge tanks we have simply taken the old slate beds of Dunbar and passed from flat fixed planes to suspended points. As in most operations where the forces of nature are used, a middle ground may be found the most advantageous. In other words, instead of unfixed suspended points we may find it well worth while to explore the possibilities of the second dimension by utilizing lines on which the gelatinous matrices may be fixed and by which the sewage may pass carrying the small amount of oxygen required for the life of organisms.

The Coal Report

THE crux of the preliminary report submitted by the President's coal commission will be found in the following sentences: "Already in our study we have come to see that underlying these immediate causes of scarcity and high prices—labor difficulties and transportation deficiency—are other causes; namely, the irregularity of demand and the overdevelopment of the mining industry. . . . While it might be expected that in an overdeveloped industry aggressive competition would have driven out mines with high producing costs and forced prices to the consumer down to a minimum, so many such complex factors have operated to prevent the free play of economic forces that a very detailed and comprehensive investigation is required before a valid conclusion can be reached." Only two remedies exist for such interference; first, a return to free competition; second, further interference. How slim is the chance that the commission will turn to the first of these may be inferred from this paragraph of its report:

> The commission believes that the public interest in coal raises fundamental questions of the relation of this industry to the nation and of the degree to which private right must yield to public welfare. It may be that both private property in an exhaustible resource and labor in a public service industry must submit to certain modificatious of their private rights, receiving in return certain guarantees and privileges not accorded to purely private business or persons in private employ.

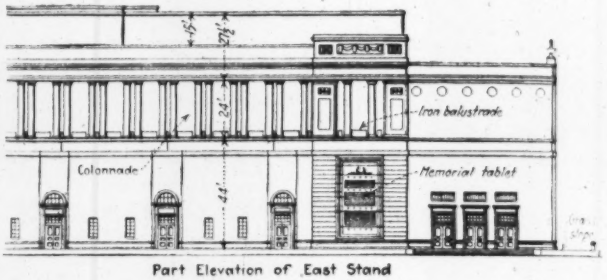
The issue here defined applies with equal force to every industry in which the normal interplay of economic interests has been found to menace the general welfare. The commission is exploring a fundamental subject and should its final conclusions support the doctrine implied in this suggestion they will carry widespread significance for the essential industries.

Illinois Stadium; a Double-Deck Steel-Frame Structure

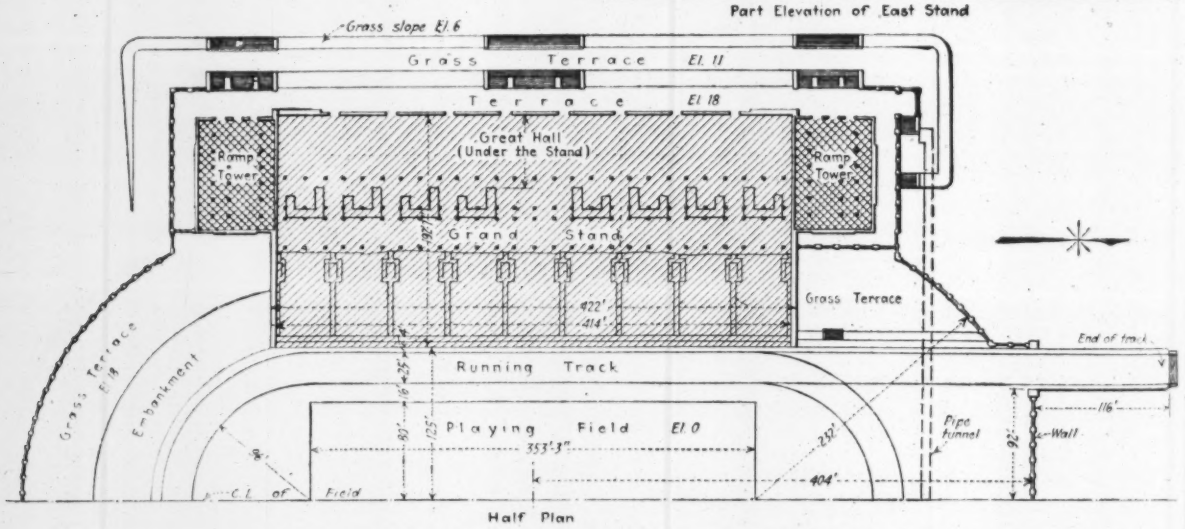
Steel and Concrete Double-Decked Side Stands Hold 60,000 Persons—Steel Trusses Carry Stands Over Large Halls for Indoor Athletics—Drainage of Arena

CONCENTRATION OF SPECTATORS in large but relatively short grandstands by means of a double-deck construction, which provides seating accommodations for 60,000 persons, is a special feature of the stadium now being built for the University of Illinois at Urbana, Ill. The reason for this design is that the main use of the stadium will be for football and it was considered that for this game side stands will afford a much better view than would be afforded by end stands supplementing the seating capacity of smaller side stands. Provision is made, however, for additional seating accomodations at the ends when required.

Since this stadium is to constitute a memorial to the students who took part in the World War it is to have more than usually elaborate architectural treatment. Colonnades surmounting the grandstands are to be a prominent feature as memorials, each of the 200 stone columns bearing the name of a man who gave his life in the war. The architectural design provides lofty walls inclosing the space beneath the grandstand and thus gives an opportunity to develop the interior for indoor athletic activities and other purposes. With this in view the structural design includes trusses which carry the decks of the grandstands and leave a wide space clear of columns.



Part Elevation of East Stand



Half Plan

FIG. 1—WAR MEMORIAL STADIUM FOR UNIVERSITY OF ILLINOIS

General Design—In plan there will be an arena 650 x 250 ft., having a football field 160 ft. wide flanked on each side by a 16-ft. safety zone for players and a 25-ft. running track, with 4-ft. clearance between the track and the grandstand, as shown in Fig. 1. These running tracks are to be connected by loops at the ends of the field, forming a quarter-mile track, but they will also be continued beyond the loop at the north end to form two straightaway tracks 220 yd. long. On each side will be a grandstand 414 ft. long and 193 ft. wide, having at each end a rectangular tower for ramps giving access to the balcony. The lower or main stand will be served by eight ramps leading from the great hall to the portals.

Steel framing was adopted for the main portion of the grandstand and for the balcony; it will not be encased in concrete but simply protected by paint, as there is no fire hazard. Reinforced concrete will be used for the decks, floors and ramps and for the framing of the front third of the grandstand. The general structural design and steel details are shown in Figs. 2 and 3. Red brick and stone trim will be used for the exterior walls, and the memorial columns will be of Bedford stone. Under each stand will be a main hall, 50 x 414 ft., a series of heavy trusses being provided in the steel framing to keep this clear of columns (see Fig. 3). These halls will be entered directly from the outside terraces. In the adjacent space provision is made for locker and toilet rooms and other facilities, while separate sets of training quarters for the visiting and home teams will be located in the lower part of two of the four corner towers.

At the top of each side structure will be the colonnade. The south end of the arena will be closed by a semicircular earth embankment, on which a masonry amphitheater may be built at some later time. A straight embankment closes the north end, except at the running track, and a tunnel 4½ ft. square under this end provides for pipe connections from the northwest tower, in which the heating plant is located.

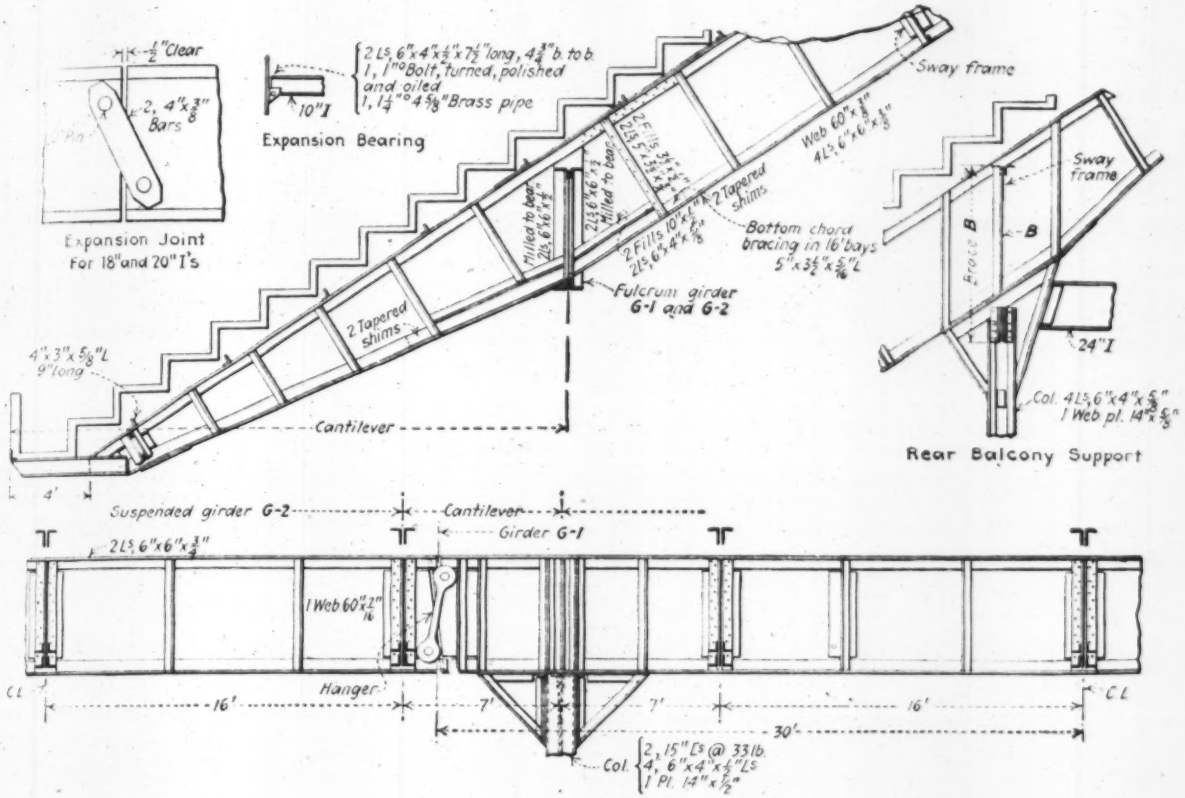


FIG. 2—STEEL DETAILS OF BALCONY

to the training quarters in the northeast tower.

For a required seating capacity of 60,000, a double-deck type of grandstand was adopted in order to limit the length to 414 ft., since football will be the principal sport and in order to provide the best view of this game is was considered desirable to mass the spectators in a space little longer than the 300-ft. playing field or gridiron. Thus the stands extend only 57 ft. beyond the goal lines. Temporary or permanent seats at the ends of the arena can be provided later to increase the capacity to 100,000. The lower deck of each grandstand has 70 rows of seats, with the top seat 62 ft. above the arena. In the balcony or upper deck there are 39 rows of seats, with front and rear rows at elevations of 58 ft. 7 in. and 110 ft. 9 in. respectively.

Expansion Joints—Careful study was given to the arrangement of expansion joints throughout the structure. There will be transverse joints 46 ft. apart, with no longitudinal joint in the balcony and two

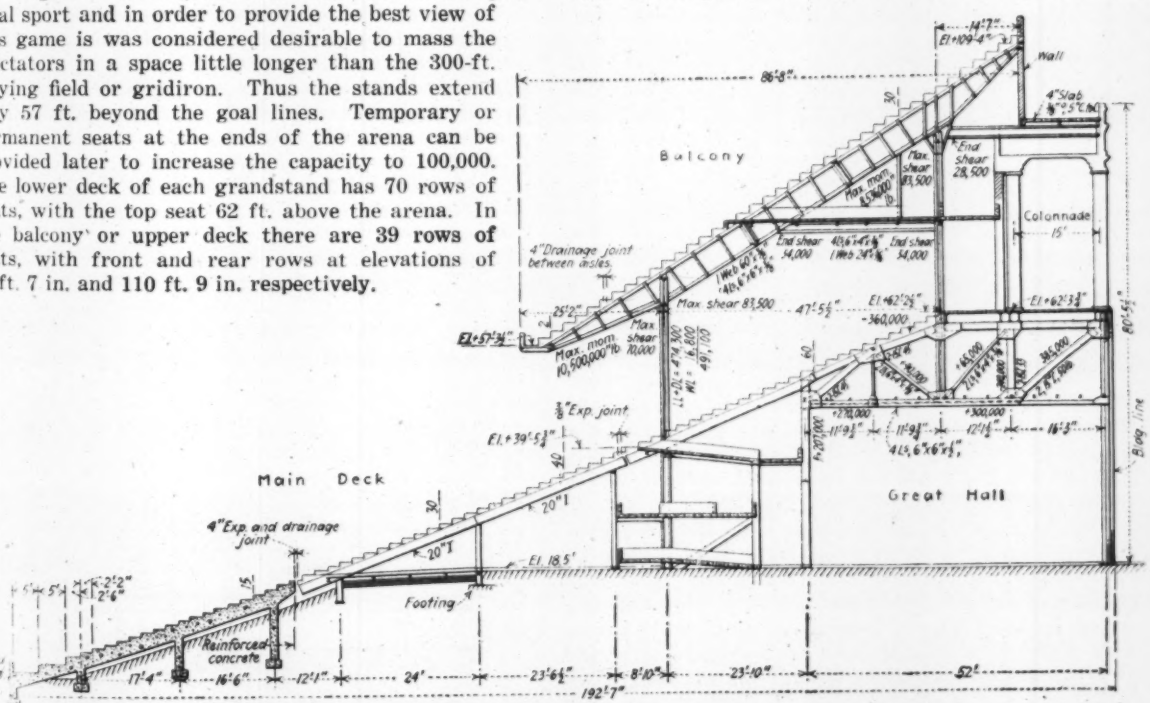


FIG. 3—STEEL AND CONCRETE DOUBLE-DECK GRANDSTAND

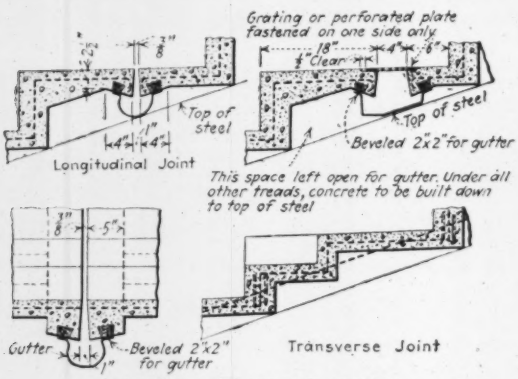

Grating or perforated plate fastened on one side only
18"
4"
6"
1" Clear
Top of steel
Top of steel
Beveled 2"x2" for gutter
Longitudinal Joint
This space left open for gutter. Under all other treads, concrete to be built down to top of steel
Gutter
Beveled 2"x2" for gutter
Transverse Joint

FIG. 4—EXPANSION JOINTS

joints in the lower deck. These joints, which are shown in Fig. 4, are carried through from the foundations to the top of the structure, so that the only resistance to expansion and contraction is that offered by the columns. Horizontal and vertical offsets had to be made at several points in order to carry the joints inconspicuously through portals, ramps and the exterior walls. No filler will be used in the joints. Sliding joints were necessary only in a few cases, and as they occur where the loads are small their details can be arranged to prevent cracking or spalling.

Structural Design—In the lower deck the steel framing is arranged in independent units corresponding to the divisions made by the expansion joints. Each unit consists of three bents spaced 16 ft. c. to c. and connected by longitudinal diagonal bracing, as shown in Figs. 5 and 6. Adjacent units are spaced 14 ft. c. to c. of bents, with 7-ft. cantilever ends for the deck framing, thus giving a spacing of 46 ft. between transverse expansion joints. Steel trusses which span the main interior halls will support the rear row of balcony columns in the colonnade and a portion of the main deck (see Fig. 3).

For the balcony, there will be one front row of columns, passing through the main deck at the entrance tunnels and extending to separate footings, as indicated in Fig. 5. In alternate bays these columns carry 60-ft. girders with 7-ft. cantilever ends, these cantilevers carrying 32-ft. suspended girders in the other alternate bays. The deck has its expansion joints over the columns, as shown. Inclined girders or floor beams have a cantilever projection of 25 ft. beyond the longitudinal girders on the front columns and 14 ft. behind the rear columns (see Fig. 3). By this arrangement there is only one row of columns to obstruct the line of sight and the columns in the row are 46 ft. apart.

It will be noted by Fig. 3 that the upper end of the balcony rises some 15 ft. above the parapet over the colonnade along the main front of the building, the steel frame being masked by a high masonry wall placed about 14 ft. back from the main wall. This arrangement was used to provide great width for the grandstand without excessive height for the front wall of the building. A roof will be provided over the upper end of the balcony.

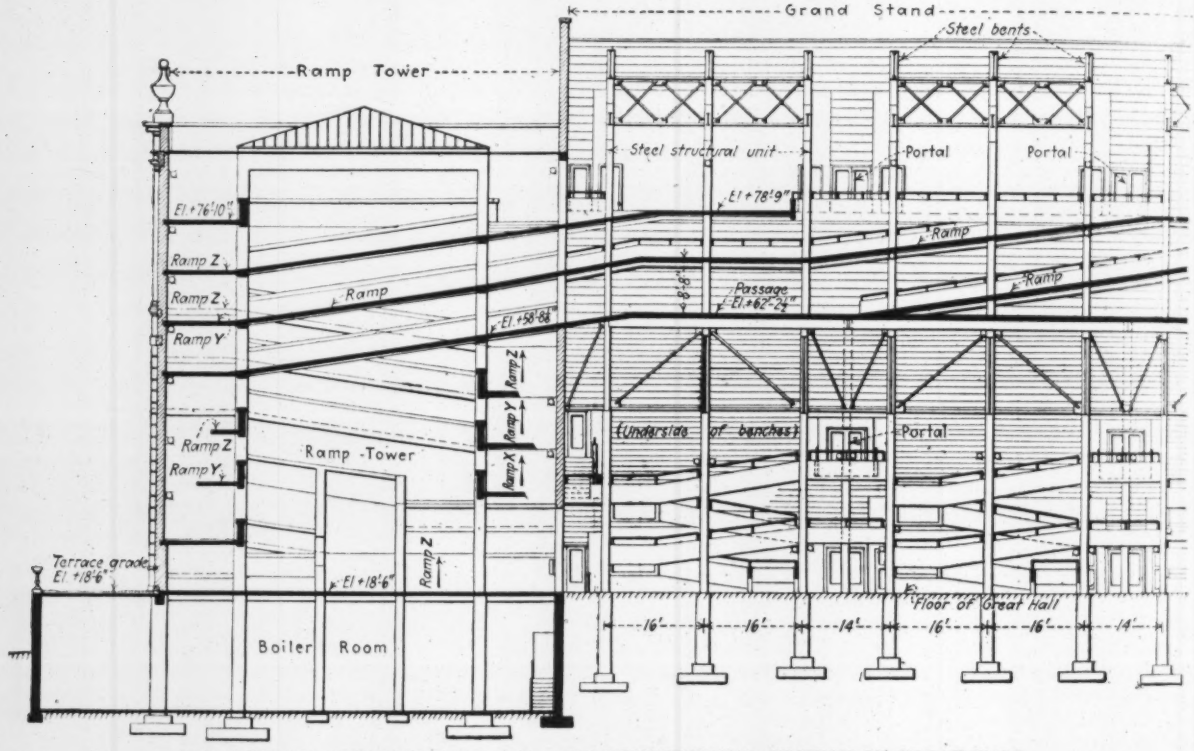


FIG. 6—RAMP ARRANGEMENT AND PART LONGITUDINAL SECTION OF GREAT HALL

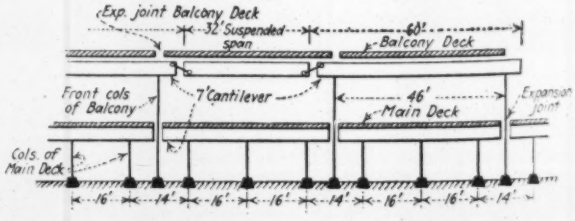


FIG. 5—LONGITUDINAL GRANDSTAND-FRAME JOINTING
Section of balcony is taken just behind balcony columns and section of main deck just in front of these columns.

In the deck construction the joists or risers are designed as continuous beams between the expansion joints, the panels being so proportioned as to give a practically uniform section from end to end. Throughout the design advantage was taken of the opportunity to use cantilever ends on the reinforced-concrete deck, on the longitudinal balcony girders and on the inclined transverse girders or floor beams of both decks.

Concrete Portion of Grandstand—In the lower part of the grandstand a reinforced-concrete construction is used, as shown in Figs. 3 and 7. Four lines of footings and columns carry girders on which the deck is formed, with a cantilever projection at the upper end where a longitudinal expansion joint separates the decks on the concrete and steel framing. In the first two benches, 5 ft. wide, the slab thickness is 3½ in., but in the 26-in. seat benches it is 2½ in. A drainage gutter in the bottom bench has a 4-in. outlet for each 46-ft. length of the stand. The excavation below grade has a slope of 3½ in. per foot and is practically parallel with the slope of the girders.

Benches and Ramps—The bench and seat construction is as shown in Fig. 8. For the benches a uniform tread or width of 26 in. is used, with a slope of ¾ in. for drainage. The thickness of concrete tread is 2½ in. Steel reinforcement consists of two rods in the top and bottom of each riser or joist and a sheet of welded wire fabric of 4 x 8-in. mesh extending through the risers and treads. The risers range in height from 8 to 11¼ in. in the main deck and from 15¾ to 17 in. in the balcony. Wood brackets anchored to the riser carry the seat, which consists of three lines of 3 x 2-in. sticks with chamfered edges, the seat projecting 4 in. in advance of the face of the riser.

A complete system of ramps for access to all parts of the grandstand is a feature of the design. Its general arrangement is shown in Fig. 6. In each of the four ramp towers, 92 x 62 ft., there will be three superimposed rectangular ramps around an open well, level landings being provided at the corners. Longitudinal ramps from these towers lead into the main building and connect with runways and lateral ramps to the seat entrances of the balcony. The lower row of portals in the main deck is served by practically level runways from the great halls of the side structures, while ramps from the level of these halls serve the upper rows of portals on this deck. The ramps and runways are of concrete, mainly 10 ft. wide, with grades of 10 to 14 per cent.

Foundations and Drainage—A good foundation for spread footings is found on the clay subsoil at a depth of about 4 ft. The footings are proportioned for a dead load of 3,000 lb. per square foot and this may be increased to about 6,000 lb. by the maximum live load.

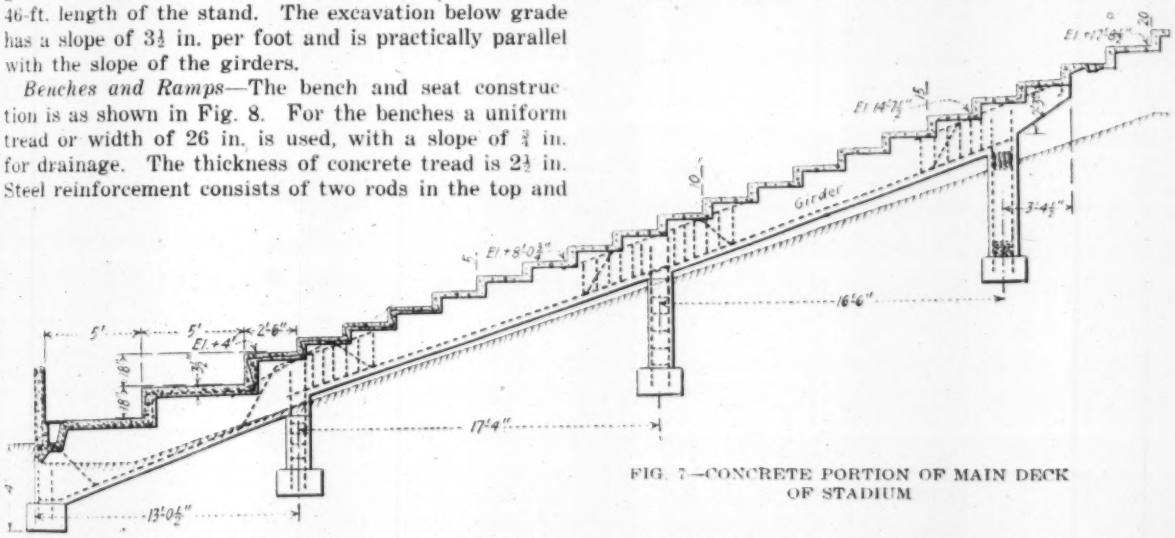


FIG. 7—CONCRETE PORTION OF MAIN DECK OF STADIUM

As the level of the field or arena is 10 ft. below average ground level and 18 ft. below the finished outside grade a thorough system of drainage is provided. Laterals of 4-in. tile laid with open joints are spaced 20 ft. c. to c. under the entire surface of the arena, including the running tracks. These laterals connect with 6-in. drains discharging into catchbasins which are spaced about 100 ft. apart along each side of the field and which serve also to carry off surface drainage. The catchbasins are connected to a 12-in. storm sewer from which a 2,000-ft. length of 24-in. sewer leads to the storm-water system of the city of Champaign.

The design for the University of Illinois stadium was made by Holabird & Roche, architects, Chicago, and the structural design was worked out under the direction of H. J. Burt, consulting engineer for the architects. The cost of the structure complete will be about $1,800,000. The contract for all the work except the steel work and the mechanical trades was let in September, 1922, to English Bros., Champaign, Ill. The contract for the fabrication and erection of the structural steel framing was let to the Fort Pitt Bridge Works, Pittsburgh, Pa., at approximately $180,000. There will be about 22,000 cu.yd. of concrete, 2,585 tons of steel and 4,800,000 brick. Work is now in progress and it is expected to have the structure ready for use by October, 1923.

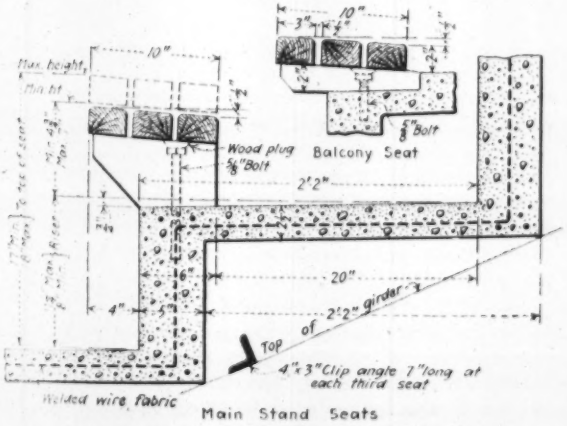


FIG. 8—BENCH AND SEAT CONSTRUCTION

Caution Plates on Motor Trucks Aid Load Control

By David C. Fenner
Manager, Public Works Department, International Motor Co

Extract from a paper presented at the joint session of the North Central Division of the National Highway Traffic Association and the Michigan State Good Roads Association.

MANUFACTURERS have suggested that state motor vehicle commissioners should refuse a state motor vehicle license for any truck which is not equipped with a manufacturer's caution plate properly stamped with the actual weight of the chassis, body and load capacity. They are now proposing to go a step further and indicate on this plate the maximum gross load for the front axle, the maximum allowable gross load for the rear axle, the maximum allowable speed and the distance in which the vehicle loaded to capacity can be stopped with each set of brakes operated independently with the vehicle running at the above maximum speed on a hard, dry, level roadway.

The information on this caution plate will give the owner the data he needs for painting the weight and carrying capacity on the sides of the vehicle to comply with the local state law. It will also enable the local enforcement officer to check up the distribution of weight between the axles, the maximum speed, and the condition of the braking system. A similar plate for use on home made trucks can be issued by the state motor vehicle department. The information contained on this plate will prevent the operation of improper trucks and force the proper operation of good trucks. It will put the penalty for poorly adjusted brakes and steering connections directly on the operator where it belongs.

Investigations conducted in some states show that light- and medium-capacity vehicles are overloaded to a greater extent and in greater numbers than heavy-capacity vehicles. This indicates the importance of restricting loads per inch width of tire per wheel and per axle. We must recognize the four classes of tire, pneumatic, cushion, solid rubber, and metal, for regulating speed and determining license fees according to wheel load.

The motor vehicle industry stands solidly behind the rigid enforcement of the provisions of the Proposed Uniform Vehicle Law and the existing state laws. It condemns overloading and overspeeding unreservedly and will co-operate actively in every movement to regulate loads and speeds of motor trucks on the highway.

Garbage and Refuse Used for Land Filling at Ottawa

By George H. Wilson
Secretary Engineering Department, Ottawa, Ont.

OTTAWA, CANADA, like Seattle, some five years ago, discarded its incinerator. Since then it has disposed of its garbage on the low spots in the outlying portions of the city. Seattle refers to its system as the "sanitary fill." Ottawa uses the term "land making."

In 1909 the city erected an incinerator of the Heenan-Froude type. Within a year it was evident that one incinerator would not burn the refuse of a city of 83,000. The city decided to build a second incinerator, but the people living around every location suggested started a rebellion. Council chose the easiest way out. It began to dump in the low land immediately around its incinerator. Part of the refuse was burned, part dumped. In 1917 it became evident that dumping could not be carried on without offense. By the judicious use of ashes, earth and disinfectants of tar-derivative type all offensive odors have been kept down.

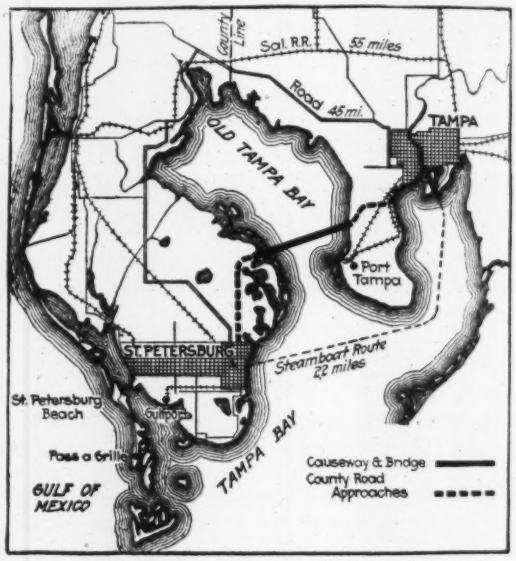
The engineering department, which is under A. F. Macallum, commissioner of works, began a definite policy of "dumping." The incinerator was shut down, and a number of low areas within a comparatively short haul were selected. Some of these spots belonged to the city; others were owned by land companies, who were glad to have gullies or low spots filled in. In one case a city street in the suburbs, which fronted on marshland, was brought to grade—a 4-ft. fill for a distance of over half a mile—entirely with refuse. To have raised this street to grade with stone or earth would have cost many thousands of dollars.

Today the "land making" policy is generally accepted by the citizens as being both wise and profitable.

Six-Mile Causeway To Cross Tampa Bay

BY BUILDING a causeway and bridge across Old Tampa Bay, the Bay Construction Co. of St. Petersburg, Fla., will provide a 19-mile route between St. Petersburg and Tampa (which lies on another branch of Tampa Bay) in place of a present highway route of 45 miles.

About 17,000 ft. of the 6-mile bay crossing will be sand-fill causeway across the shallow, protected waters



NEW ST. PETERSBURG-TAMPA ROUTE
Makes distance between the two cities 19 mi., saving 26 mi. over present road connection. Includes 3¼ mi. of causeway and 2¾ mi. reinforced-concrete bridge with draw.

of the bay, while 14,500 ft. will be reinforced-concrete bridge, including the 75-ft. bascule draw near the eastern end. The roadway over the crossing is planned to be 24 ft. wide, the pavement over the fill being 8 in. thick. A single line of track is to be laid down at the time of construction for future installation of trolley service, but the road is intended to serve automobile traffic essentially.

An interesting feature of the project is that it is proposed to light the crossing so effectively as to make it unnecessary for automobiles to use headlights at night.

The project was conceived by George S. Gandy, Sr., formerly of Philadelphia, and is named the Gandy Bridge after him. He secured a charter from the Florida Legislature, and organized the company which is to build it. W. G. Thompson, former state highway engineer of New Jersey, has been engaged as chief engineer of the company, and will be in charge of the designing and building of the bay crossing.

250-Year Old Marly Waterwheels for Versailles Fountains

Water Pumped to Aqueduct 4,000 Ft. Away, 500 ft. Higher—Gravity Fall to Fountains—200 Pumps, 15 Mi. Cast-Iron Pipe

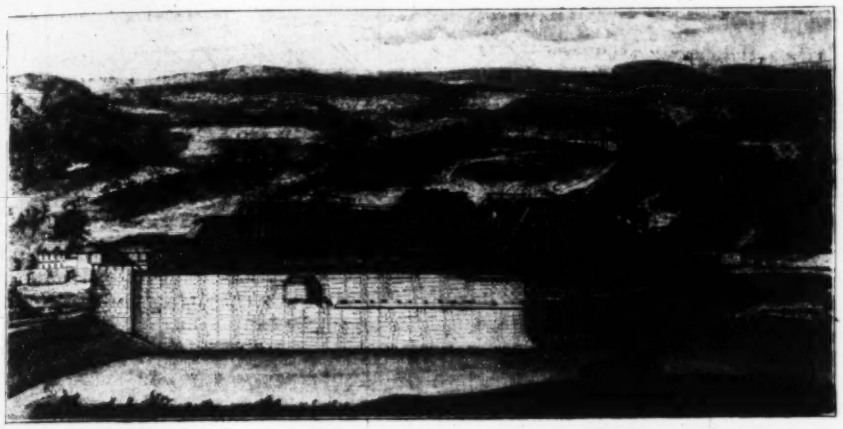
AT MARLY on the Seine near Paris between 1664 and 1685 Louis XIV had built by engineers whose names are now forgotten a most remarkable pumping plant to supply water for the fountains at Versailles. Kingly jealousy was the genesis of the idea of building the pumps. The king of Spain had famous fountains at one of his palaces which were supplied by gravity from a hillside reservoir. Louis XIV had no hill but he determined to outdo the fountains in Spain and set his engineers to the task.

This installation, the forerunner of the larger size pumping equipment by means of water power, consisted of undershot waterwheels operating walking-beam pumps whose tops are shown at the left in the view. Water was pumped to the aqueduct shown at the top of one of the pictures, 4,000 ft. away and at a difference in level of 500 ft. This elevation was reached in three stages, the motive power for the upper stages being transmitted by rods. The multi-stage development was essential because pressures due to 500-ft. head could not be confined in the flanged cast-iron pipe of that day. From the aqueduct the water flowed by gravity to the fountain. Altogether about 200 pumps were used and 15 miles of pipe lines. The waterwheels were 30 ft. in diameter and had paddles 6 ft. wide.

The machine here shown was in use until the time of Napoleon I. About 1803 it was replaced by a steam engine designed by James Watt. The steam-driven pumps in turn were replaced by hydraulic machinery now in use.

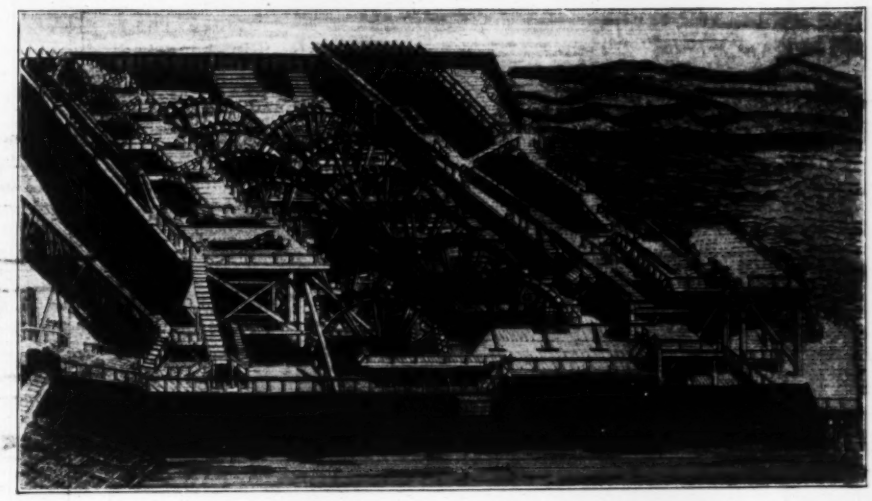
The pipe founder has always been interested in the fact that the cast-iron flanged pipe used in this system is still in use and in good condition. It was cast in meter lengths and bolted.

Many English books on hydraulics refer to the Marly installation but few present illustrations. The colored woodcuts from which these halftones were reproduced by utilizing color screens were picked up in a curio shop in Besançon by Major Paul M. LaBach, engineer, water services, Chicago, Rock Island & Pacific R.R., and are probably at least 150 years old. In a visit to Versailles Major LaBach was fortunate enough to see repairs on one of the 250-year-old pipe lines to one of the fountains. The pipe which had been broken out appeared to be of gray cast iron in good condition.



MARLY WATERWHEELS ON THE SEINE

Water for the Versailles fountains was raised 500-ft. in three lifts and then delivered into an aqueduct at the point "T" in the upper right-hand of the view. Pump rods transmitted power up the hill to the two sub-stations. Historians remark on the terrible clanking of these rods.



WHEELS FOR THE WALKING BEAM PUMPS (LEFT) AND FOR THE PUMP RODS (RIGHT)

Undershot wheels driving about 200 pumps were 30-ft. in diameter and had paddles, against which the water impinged, 6-ft. wide. The rods carrying power to the substations are shown in the center background.

Tests of Knees for Continuous Frame Concrete Bridges

Results Show Efficiency of Detail of Specially Designed Highway Bridges Used on Bronx Parkway Roads

By Arthur G. Hayden

Senior Assistant Engineer in Charge of Design, Bronx Parkway Commission, Bronxville, N. Y.

In connection with the development of the design for the continuous-frame reinforced-concrete highway bridge described in *Engineering News-Record*, Jan. 11, 1923, p. 73, for the Bronx Parkway Commission, several interesting tests were conducted in the engineering laboratory of Columbia University. In the first studies for Swain St. bridge, the first of the bridges of this type, the intrados was much flatter than in the accepted design, the required clearance over the driveway curbs being afterwards reduced in order to obtain a more graceful structure with greater rise from springing to crown. The original design necessitated a thin section across the knee on account of the grade of Swain St. and made these points the critical points of the design.

It is well understood that the stresses in a curved

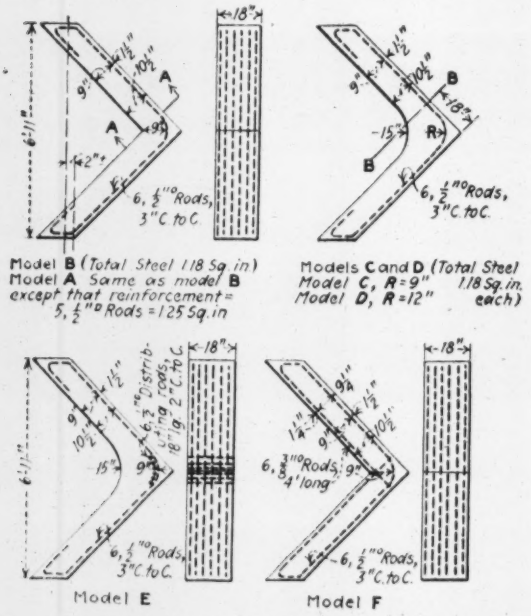

Model B (Total Steel 1.18 Sq. in)
Model A Same as model B except that reinforcement = 5, ½"□ Rods = 1.25 Sq. in
Models C and D (Total Steel 1.18 Sq. in. each)
Model C, R=9"
Model D, R=12"
Model E
Model F

FIG. 1—DETAILS OF TYPES OF CONCRETE KNEES TESTED

beam are different than in a straight beam. Applying the formula for curved beams to a right-angle bend subjected to bending, the computed stress at the root of the bend is infinite. This presumes Hooke's law to hold true, which in the nature of things cannot be the case and thus the curved-beam formula does not apply.

Data of tests of reinforced-concrete knees were needed which would indicate the efficiency of such a detail in terms of the applied bending moment. The writer corresponded with several authorities, but could not find that tests had been made of this detail in its simplest form, but in structures where other effects were present. L. G. Holleran, deputy chief engineer of the Bronx Parkway Commission, recommended to Jay Downer, engineer and secretary, that tests be made. The recommendation was approved and an appropriation made.

The general result of the tests is interesting, in view of the fact that several authorities in reinforced-concrete design predicted failure at the knees at much lower loads than those actually sustained. The number of tests permitted were too few to be of great theoretical value—little more than a determination of the proper factor of safety to be used in proportioning the sections at the knees being hoped for. An attempt was made, however, to determine the effect of certain secondary elements of design, but for the most part only negative results were obtained, and further tests are needed.

Six models were made in all—three with square

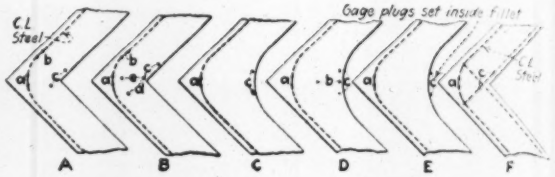


FIG. 2—LOCATION OF STRAIN GAGE PLUGS ON TEST PIECES

corners (A, B and F) and three with filleted corners (C, D and E). Some authorities predicted that the square cornered models would fail at very low loads across the knee on account of the peculiar conditions of stress that would develop around the bend. It was expected by some that the filleted models would also develop weakness at the knee; but this did not occur, so that the tests of the filleted models gave negative results. The reinforcing rods in five of the models had 9-in. bend radius around the bend and one had 12-in. bend radius; one model (E) had distributing rods on the inside of the bend. But in none of the models did the concrete crush under the steel at the bend, so that the value of the distributing rods as well as the effect of varying the bend radius of the main reinforcing rods is not apparent. One model (F) had compressive reinforcement in addition to the tensile reinforcement, but the value of this cannot be determined by comparing the results of the tests of model F with the other models of the same type, because of the great difference in the quality of concrete. Model F was cast without inspection (on election day morning) and the model itself, as well as the test cylinder belonging to it, showed an inferior grade of concrete. This explains the low ultimate load for model F as compared with model A. Though negative results were obtained as to the effect of such details, the general result of the tests is interesting.

The models were cast in the field by the commission's forces, five being cast in succession without interruption. Model F was cast on a different day. One concrete test cylinder, 8 in. in diameter, 18 in. long, was cast with each model for the purpose of determining the properties of the concrete in the models. A small shovelful of concrete was used from each batch poured into the model. Each cylinder bore the same letter as the model to which it belonged.

Specimens of the steel used in the models were tested and showed a yield-point of about 45,000 lb. per sq.in. and ultimate strength of about 75,000 lb. per sq.in.

The load, applied to the ends of the arms of the models by the testing machine, was localized, as shown

in the sketch of model B, by means of narrow shims. The models were white-washed so as to facilitate the detection of tension cracks and, as the load was increased, each model was scrutinized through a magnifying glass for the developments of cracks. As these appeared, they were traced with black crayon so as to appear in the photographs.

Strain-gage readings were taken on the tension steel at the middle of the bend in the knees and on the concrete on the inside of the bend and deflection readings between the extremities of the two arms. The location of the strain gage plugs is shown in Fig. 6.

It should be noted that in model B, the concrete strain curve for gage "d" has quite a different characteristic than the curve for gage "c"; and that it is, therefore, unfortunate that the "c" gage readings for models A and F combine the two effects which cannot be separated. The higher steel stress and lower ultimate load of model F as compared with model A of the same type is explained by the poor grade of concrete in this model as before mentioned. The higher steel stress (above 13,000 lb. load) and lower ultimate load of model B, as compared with model A of the same type, is explained by the fact that the reinforcing steel was inaccurately placed; the effective depth of the steel across the knee being less than 8 in. instead of 9 in. as called for on the plan. This model also developed tension cracks across the knee earlier than models A and F.

Examination of the tension cracks at the knees of models A, B and F indicates that the neutral axis at the root of the bend is very near the root—less than 2 in., and that the compression in the concrete at the root of the bend must be very high; but the concrete is confined by compressive forces in several directions and compressive failure within the root is prevented until the structure as a whole is destroyed. Fig. 5 shows that the stress in the steel at the middle of the bend of the filleted models (C, D and E) is very small.

The only pronounced compression failure was in model A and that at very high applied load. Critical stresses do not develop across the knee earlier than on a right-section immediately in front of the knee, so

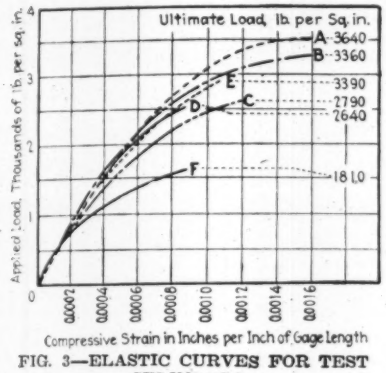


FIG. 3—ELASTIC CURVES FOR TEST CYLINDERS

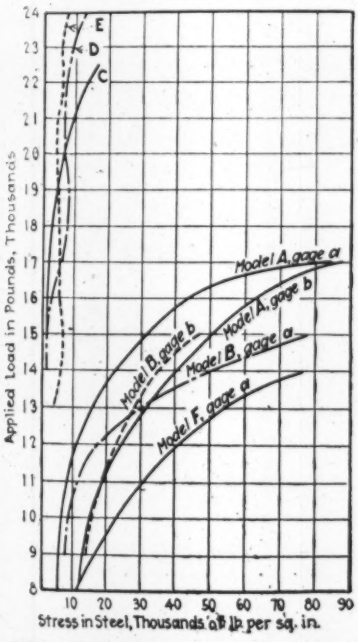

Model A, gage a
Model A, gage b
Model B, gage b
Model B, gage a
Model F, gage a
Applied Load in Pounds, Thousands
Stress in Steel, Thousands of lb. per sq. in.

FIG. 5—STRESSES IN TENSION STEEL
Computed stresses above yield-point (45,000 lb. sq.in.) based on constant modulus of elasticity = 29,000,000.

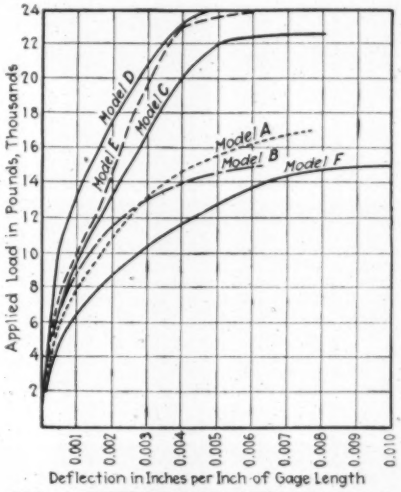


FIG. 4—DEFLECTION BETWEEN ENDS OF LEGS

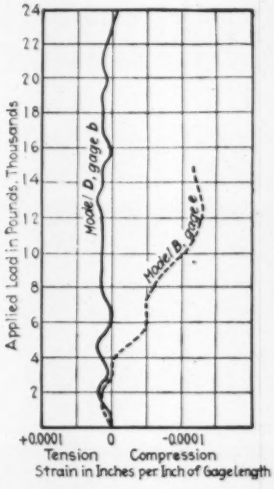


FIG. 7—DIAGONAL STRAINS IN CONCRETE AT KNEE

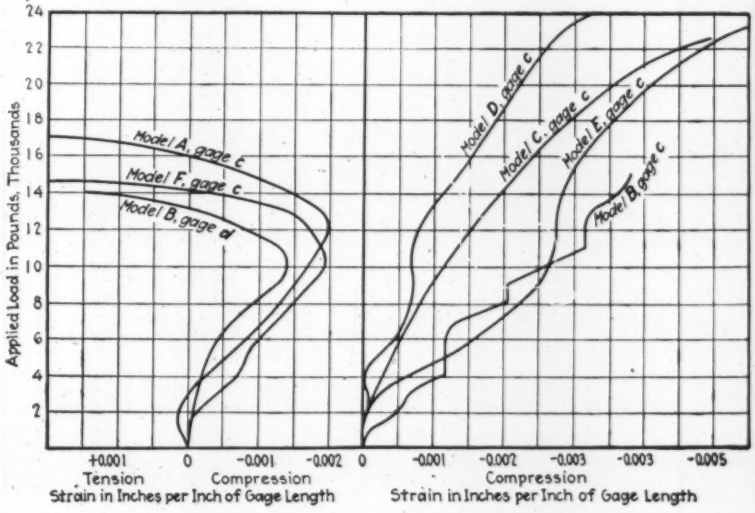


FIG. 6—LONGITUDINAL STRAINS IN CONCRETE AT BEND OF KNEE

TABLE SHOWING COMPUTED STRESSES IN TEST KNEES

	A	B	F	C	D	E
Load at first tension-crack (lb.)	7,000		6,900	13,000	13,000	13,000
Load "b" (lb.)	16,000	14,000	12,000	20,000	23,000	23,000
Ultimate load (lb.)	19,300	16,000	15,900	23,300	25,600	25,800
Computed steel stress at load "b" (lb. per sq.in.)	48,700	45,800	41,400	40,000	45,600	45,600
Computed concrete stress at load "b" (lb. per sq.in.)	2,710	2,540	1,930	1,940	2,230	2,230

The transverse shear on the right section is in all cases equal to 960 lb. + 0.7 the applied load.

that such a detail may be designed for the bending moment on the right section as for an ordinary cantilever beam provided the same effective depth is maintained around the bend.

In the accompanying table the stresses for models A, B and F are computed on a right section at the knee as indicated by line A-A in the sketch for model B; and for models C, D and E on a right section near the knee as indicated by line B-B on the sketch for models C and D. The computed stresses take account of the direct compression as well as the bending moment, but the direct compressive stresses are small in comparison with

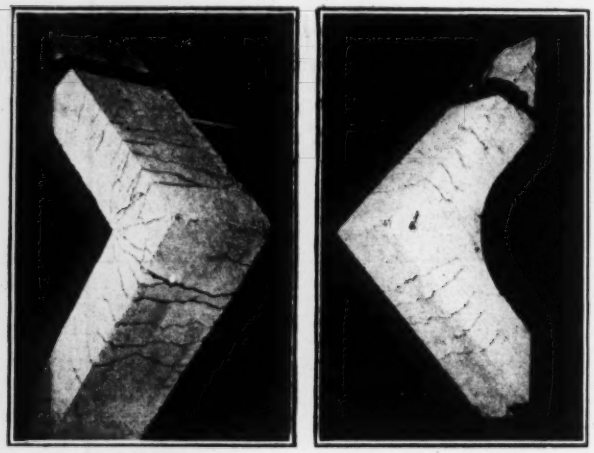


FIG. 8—TYPICAL KNEES AFTER TESTING
(At left) Knee A at 19,200 lb. load. (At right) Knee C at 20,000 lb.

the bending stresses. The ratio of modulus of elasticity in the steel to that in the concrete was computed each time from the elastic curve for the test cylinders as shown in Chart A, and varied from 8 to 10. The only exception was made in the case of model F. The surface of test cylinder F was defective, an area of 2 x 4 in. being unfilled for a depth of ½ in., and the results of the test were not considered to be reliable, so a ratio of moduli of 10 was assumed in computing the stresses in model F.

Straight-line variation of stresses was assumed in computation, therefore the computed stresses are not the actual stresses, but do give an idea of the capacity of the knees.

The condition of the knees at the loads for which the stresses are computed is shown in the typical photographs.

The models, test cylinders and steel specimens were tested in the engineering laboratory of Columbia University under the direction of Professors A. H. Beyer, W. J. Krefeldt, G. E. Orthey and J. S. Peck of the laboratory staff, to whom should be given credit for the conduct of the tests.

Portland Water-Works Improvements Completed and Projected

New Headworks Bring Section 1 of Steel Conduits to Designed Capacity—Third Steel Pipe Line and Storage Projected

BY W. P. HARDESTY
Civil Engineer, Portland, Ore.

NATURAL growth of the city and environs calling for increased supply, practical experience showing limitations of formula for computing delivery of water through pipes, construction of new diversion headworks with some novel features and plans for increased supply have been among the recent developments connected with the water supply of Portland, Oregon.

The water supply of Portland has long stood in the first rank among all the cities of the world as regards purity and constancy of supply. The water is obtained from the Bull Run Reserve, set apart by the federal government 30 years ago. Monthly analyses of the supply show only 25 p.p.m. of dissolved solids, mostly magnesium and calcium salts. No bacteria have ever been found.

Portland's duplicate gravity supply mains, reaching from the diversion at Bull Run River to the reservoir system on Mt. Tabor (in East Portland), are each over 24 miles long. Controlling summits divide the conduits into three sections, each with its independent hydraulic grade line. The first section is 10 miles long and actual use has demonstrated that it is inferior in delivery capacity to the two following ones, nearer the city, though all had been carefully figured out to the same formula and coefficient. This inferior capacity appears to be due to the much greater number of short bends in the pipe, occasioned by the rougher topography of the first section. The same results appear in the original 42-in. riveted and in the second 52-in. lockbar steel pipe.

The above noted defect in Section No. 1 of the pipe line, coupled with need of other betterments at the headworks, have resulted in some radical changes, recently completed, which have increased the head and delivery of the first section of the two conduits. A third conduit is to be built. Studies for storage have been made.

New Diversion Headworks—The old diversion, in use since 1895, served well its purpose for many years. The diversion was effected without any dam by direct entry of water into a head-canal leading to the regulating house. But of recent years the *entire* low-water flow of the river has been required, and this is difficult without a dam. Much sand and gravel also washed in during flood stages, at which times the work of clearing the screens of trash was considerable.

The new headworks are located about 100 yd. above the old ones. They include a concrete dam, sluice and diversion gates; a canal and a screen-house. The dam is 170 ft. long and 30 ft. high, being a gravity type Ogee rollway, keyed-in to the bedrock.

On the south side of the dam is the intake, set back from the current and protected by a floating boom. Here a pair of 48 x 72-in. sluice gates permit draining water off to bottom of the dam. At the entrance of the diversion canal (leading off at right angles to the river and protected by rack screens) is a set of three 48 x 72-in. sluice-type diversion gates. These provide for draw-

ing off the water at the desired levels between the surface and bottom, so that only *suspended* matter is carried.

The screenhouse is equipped with two sets of ½-in. mesh Link-Belt traveling screens, each 7 ft. wide and moving at a rate of 10 ft. per minute through a water depth of 20 ft. Cleansing is effected by a series of water jets, applied both at right and oblique angles under an 80-lb. gravity pressure supplied by a 4-in. pipe that taps a branch stream high above the main cañon.

From the screenhouse, connecting pipes lead to the 42-in. and 52-in. mains supplying the city. Provision is made throughout the new works for attachment to a third main, to be constructed in the near future.

All these structures are built of concrete, using about 10,000 cu.yd. The dam and most of the other works are plain concrete, and the remainder are reinforced. No sand in deposits is available in the vicinity, so sand was shipped from Portland to the end of the electric railway and thence hauled over the difficult road to the work. Rock for crushing was obtained at and near the dam site.

The contractor for the works recently completed was the Hauser Construction Co., of Portland. The total cost to the city was about $270,000.

By the new diversion an initial head of about 30 ft. is added for Section No. 1 of the pipe line, before mentioned, thus making its capacity equal to that of the remaining sections, besides which a better utilization and control of the water has been provided.

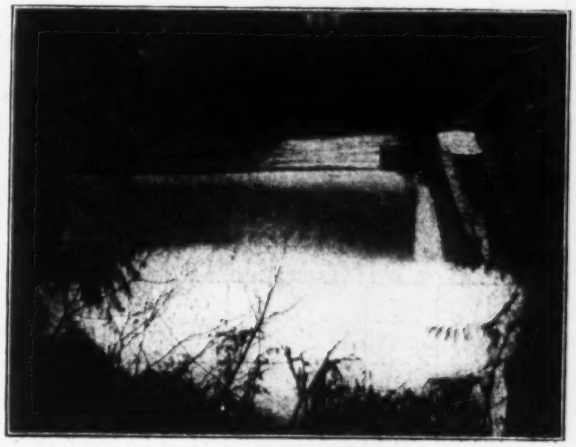
Storage Development—Bull Run River has its source in Bull Run Lake, on the west slope of the Cascade Range, twenty miles above the headworks just described. The entire drainage area of the river is rugged and picturesque—all but inaccessible save for one or two trails. The mean annual precipitation ranges from 90 in. at the

NEW HEADWORKS FOR PORTLAND WATER SUPPLY
Looking up canal towards diversion gates. Sluice gates at left. Overfall of dam not yet built but one wing wall has been completed.

headworks to 150 in. at the lake. The low-water flow at a point slightly above the headworks, from records kept since 1895, ranges from 70 to 100 sec.-ft., while there is a recorded maximum of over 20,000 sec.-ft. The first pipe line had a capacity of about 22.5 and the second one of about 43 m.g.d. These easily carry the natural low-water supply.

Increased population has rendered storage necessary. The most readily utilizable means is the lake itself. Bull Run Lake has an area of about 500 acres and a drainage area of about 4 sq.mi. At the outlet end the water disappears in the rocks and does not reappear until one mile down the cañon.

A beginning in storage has been made in the past year by using types of construction naturally adapted to local conditions, as all outside materials, appliances and supplies have to be brought in over an 11-mi. pack trail. By the expenditure of $40,000 a material addition to the summer supply of Portland has been made.



WATER-WORKS DIVERSION DAM ON BULL RUN
Concrete overfall and wing walls. Sluice gates at right

The Bull Run gathering ground, 102 sq.mi. in area, is the only undefiled source at present controlled by the City of Portland. The average annual runoff is about 750 sec.-ft., sufficient for a city of several million people if all utilized. With an eye to the future, many preliminary surveys and computations have already been made looking to the increasing utilization of this supply. Besides the lake there are other less natural sites along the river itself, besides some side cañons leading out from flatter basins above. Natural dam sites abound because of the frequent narrow rock cañons, but with many the natural storage available is limited. Altogether thirteen different additional storage projects of from 2,000 to 19,000 acre-ft. have been considered. The complete storage cost is estimated at $15,000,000.

Additional Supply Main—The two pipe lines already mentioned have a delivery capacity of 65,500 m.g.d. To provide for the immediate growth of the city, plans have been prepared for a third main. The two existing mains occupy about all the available ground along their route, including bridge room. An additional reason for a separate location is the desirability of so segregating the supply lines that possible breaks or stoppages from whatever cause, including slides and washouts, collapse or burning of bridges, should not throw all the lines out of commission. The new main will consequently have an entirely separate location.

The size of pipe will be 60 in. if of riveted steel, and probably only 58 in. if the lockbar type be chosen, and the capacity will be 60 m.g.d. The estimated cost is $2,000,000. It is planned to award contracts for the new line in the spring of 1923, with two years for completion. The sum of $1,000,000 has been set aside for a start, and also $2,500,000 for extensions and betterments in the city itself.

For data from which this article has been prepared the writer is indebted to F. M. Randlett, chief engineer of the Water Bureau of Portland.

Hydrologic Record of the Mississippi Floods from 1882 to 1922

Official Statement of Gage Heights From Cairo to the Gulf in All the High Waters of the Past 40 Years —Record of the Present Status of Levee Construction

By Edward N. Chisolm
Captain, Corps of Engineers, U. S. A.; Secretary, Mississippi River Commission, St. Louis, Mo.

THE 1922 flood on the Mississippi River began in February and had its origin from a moderate rise in the Ohio River. On Feb. 16 at Cairo, Ill., beginning with a stage of 18.3 ft. on the Cairo gage, there was a continuous rise until March 25, when a stage of 53.6 ft. was reached, when the river receded to 49.9 ft. on April 9 and 10. The second rise began on April 9 and continued until April 25, when a stage of 53.5 ft. was recorded, which was 0.1 ft. lower than the crest of March 25.

In addition to the flood water entering the Mississippi from the Ohio on March 1, a disturbance developed over the lower river valley and rains of more or less intensity resulted, together with 6 to 7 in. of snow in northern Arkansas and Missouri. This resulted in a rise of the lower tributaries of the river about the time the waters of the Ohio were reaching this portion of the river. During the first week of April all tributaries north of the Missouri reached flood stages. At Muscatine, Iowa, the crest was reached on April 24; gage read 17 ft.; discharge observations showed 288,572 sec.-ft. This condition, along with several other disturbances, had a tendency to prolong the flood.

From observations made during the flood it was noted that the time interval between the two crests was 30 days at Cairo, Ill., 30 days at Mhoon Landing, Miss., a distance by river of 273 miles; 27 days at Sunflower Landing, Miss., a distance of 81 miles; and only 11 days at Arkansas City, a distance of 83 miles.

High water in the Arkansas River culminated at Little Rock, Ark., on April 16, and in White River at Clarendon, on April 19 and 20, caused the Mississippi to rise slowly at Arkansas City until April 22, seventeen days after the crest of the first rise in the Mississippi had passed Sunflower Landing.

The crests of the two rises did not differ by more

TABLE I. GAGE READINGS ON MISSISSIPPI TRIBUTARIES, 1882-1922

(Date of crest at Cairo is given and readings at other stations correspond to these dates, allowing proper time interval for travel to Cairo. Max. of rise given in parentheses)

Year	Date at Cairo	Cairo Gage Reading	St. Louis Gage Reading (3 Days Earlier)	Ohio River, Paducah, Gage Reading (1 Day Earlier)	Ohio River, Evansville, Gage Reading (3 Days Earlier)	Ohio River, Cincinnati, Gage Reading (5 Days Earlier)	Ohio River, Pittsburgh, Gage Reading (9 Days Earlier)	Tennessee River Florence, Gage Reading, (3 Days Earlier)	Cumberland River, Nashville, Gage Reading (3 Days Earlier)	Wabash River Mount Carmel Gage Reading (3 Days Earlier)
		Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
1882	Feb. 26	51.87	27.10 (July 5, 32.39)	49.78 (Feb. 26, 49.95)	44.60 (Feb. 24, 44.90)	58.58 (Feb. 21, 58.58)	10.90 (Jan. 28, 21.50)	13.60 (Jan. 22, 29.60)	35.60 (Jan. 22, 55 30)	No record
1883	Feb. 27	52.17	25.50 (June 26, 34.80)	50.60 (Feb. 25, 50.70)	46.20 (Feb. 19, 47.80)	54.00 (Feb. 15, 66.33)	19.80 (Feb. 8, 26.80)	7.80 (Jan. 28, 23.30)	16.70 (Feb. 14, 41.60)	No record
1884	Feb. 22-24	51.79	14.70 (Apr. 9, 10, 28.10)	53.95 (Feb. 23, 54.25)	48.80 (Feb. 19, 48.80)	65.50 (Feb. 14, 71.06)	17.80 (Feb. 6, 31.90)	22.00 (Mar.14, 25.20)	42.40 (Mar. 15.48. 30)	No record
1886	Apr. 19	51.02	20.80 (May. 13, 27.00)	50.00 (Apr. 17. 50.40)	42.90 (Apr. 14, 43.40)	49.00 (Apr. 9, 55.75)	14.10 (Apr. 7, 22.20)	18.70 (Apr. 8, 28.10)	29.20 (Apr. 10, 49.30)	14.10 (May 22, 19.80
1893	May 9	49.33	29.30 (May 3, 31.60)	42.30 (Feb. 27, 44.30)	40.20 (Feb. 24, 41.80)	47.80 (Feb. 21, 54.58)	8.90 (Feb. 8, 23.10)	14.80 (Feb. 17, 21.40)	16.80 (Feb. 22, 40.80)	24.20 (May 8, 24.50
1897	Mar. 25, 26	51.72	18.80 (May 2, 30.95)	50.90 (Mar. 24, 50.90) 25,	39.90 (Mar. 2, 43.60) 3.	40.30 (Feb. 26, 61.10)	9.40 (Feb. 24, 28.90)	27.50 (Mar.19, 32.20)	47.20 (Mar.20, 49. 25)	21.10 (Mar. 13, 26.40
1898	Apr. 6	49.78	20.20 (May 25, 27.20)	47.10 (Apr. 6, 47.30	44.80 (Apr. 2, 44.80)	55.40 (Mar.28, 61.10)	11.40 (Mar.24, 28.50)	10.90 (Jan. 20, 13.80)	19.80 (Jan. 23, 38.80)	25.60 (Mar.30, 27.00
1903	Mar. 16, 17	50.57	24.50 (June 10, 38.00)	47.60 (Mar.15, 47.60)	42.00 (Mar.11, 42.40)	49.20 (Mar. 5, 53.20)	9.50 (Mar. 1, 28.90)	16.80 (Mar. 6, 18.82)	37.40 (Mar. 9, 40.60)	22.20 (Mar.12, 22.30
1907	Jan. 27	50.33	26.10 (July 25, 28.00)	45.00 (Jan. 28, 45.70)	46.20 (Jan. 24, 46.20)	64.50 (Jan. 21, 65.10)	20.10 (Mar.15, 35.50)	4.90 (Mar. 5, 14.50)	28.20 (Mar. 3, 38.90)	23.50 (Jan. 28, 24.50
1912	Apr. 6, 7	53.95	29.85 (Apr. 5, 30.80)	49.40 (Apr. 8, 49.90)	42.10 (Mar.31, 42.60)	46.80 (Mar.27, 53.20)	9.40 (Mar.22, 28.10)	19.58 (Apr. 3, 19.58)	45.30 (Apr. 8, 46.60)	22.40 (Apr. 7, 23.20
1913 (First rise)	Jan. 28	48.89	9.70 (Jan. 25, 9.70)	47.50 (Jan. 25, 47.60)	44.70 (Jan. 20, 46.70)	45.50 (Jan. 15, 62.20)	14.70 (Jan. 9, 31.30)	12.70 (Jan. 28, 17.00)	33.50 (Jan. 14, 48.40)	22.90 (Jan. 30, 24.30
1913 (Second rise)	Apr. 7	54.69	21.60 (Apr. 16, 27.20) 17,	54.10 (Apr. 7, 54.30)	48.20 (Apr. 5, 48.30)	69.50 (Apr. 1, 69.80)	7.90 (Mar.28, 30.40)	Feb. 1, 17.60 (Mar.21, 18.47)	44.00 (Apr. 2, 44.90)	26.40 (Mar.30, 31.00
1916	Feb. 4,	53.21	31.40 (Jan. 31, 31.40)	43.8 (Jan. 18, 45.7)	38.7 (Jan. 18, 43.6)	35.3 (Apr. 1, 53.5)	8.5 (Mar. 29, 21.8)	9.0 (July 12, 20.46)	20.4 (Jan. 5, 42.40)	22.4 (Feb. 6, 26.5
1920	Mar. 31	51.40	24.7 (Apr. 24, May 22, 28.0)	44.5 (Mar. 28, 45.3)	41.3 (Mar. 25, 42.8)	43.5 (Mar. 22, 54.6)	12.6 (Mar. 14, 24.5)	11.2 (Apr. 10, 23.5)	14.7 (Jan. 30, 44.10)	16.7 (Apr. 28, 23.6
1922	Mar. 26	53.60	21.5 (Apr. 19, 33.95)	48.8 (Mar. 24, 48.8)	42.5 (Mar. 21, 42.9)	47.2 (Mar. 18, 52.1)	15.0 (Mar. 16, 18.3)	12.8 (Mar. 11, 21.0)	27.80 (Mar. 16, 45.1)	24.1 (Apr. 23, 26.3
		1913 54 69	1884 41.39	1913 54.3	1884 48.8	1884 71.06	1907 35.5	1897 32.20	A1882 55.30	1913 31.0

A—Maximum gage readings prior to 1922.

TABLE II—CONDITION OF MISSISSIPPI LEVEE SYSTEM, 1922

Levee District	In System Miles	Built Miles	Contents 1921 Cu. Yd.	Built Since by United States Cu. Yd.	Built Since by Local Authorities Cu. Yd.	Total Built Since 1921 Cu. Yd.	Lost or Abandoned During the Year Cu. Yd.	Contents, 1922 Cu. Yd.	Required to Complete Cu. Yd.	Estimated Final Contents Cu. Yd.	Per Cent Now Built	Approximate Area Protected Sq. Mi.
Rock Island to New Boston, Ill.	25	25	1,956,884	283,968	.....	283,968	.....	2,240,852	1,029,500	3,270,352	68.5	44
Muscatine to mouth of Iowa River, Iowa	20	20	1,238,143	174,026	327,190	501,216	.....	1,739,359	227,000	1,966,359	88.5	34
Mouth of Iowa River to Burlington, Iowa	28	28	1,330,500	.....	.....	.....	23,786	1,306,714	873,786	2,180,500	59.9	70
Mouth of Des Moines River to LaGrange, Mo.	5	5	285,655	.....	.....	.....	7,000	278,655	7,000	285,655	97.6	12
Warsaw to Quincy, Ill.	17	17	1,553,063	199,377	.....	199,377	.....	1,752,440	33,000	1,785,440	98.2	46
Quincy to Hamburg Bay, Ill.	53	53	4,875,549	813,265	.....	813,265	.....	5,688,814	2,275,000	7,963,814	71.4	172
LaGrange to mouth of Missouri River, Mo.	23	20	1,298,763	168,445	.....	168,445	.....	1,467,208	451,000	1,918,208	76.5	45
Head of Chouteau Island to Prairie du Pont, Ill.	21	21	2,632,235	.....	.....	.....	.....	2,632,235	.....	2,632,235	100.0	96
Prairie du Pont to Grand Tower, Ill.	16	16	445,153	44,587	.....	44,587	35,000	454,740	35,000	489,740	92.9	45
Grand Tower to Gale, Ill.	22	22	1,386,866	120,419	.....	120,419	85,000	1,422,285	26,500	1,448,785	98.2	45
Upper St. Francis	87	78.30	9,347,947	1,418,826	12,079	1,430,905	.....	10,778,852	3,515,987	14,294,839	75.4	700
Lower St. Francis	218	218	50,829,199	2,768,717	63,324	2,832,041	.....	53,661,240	10,214,760	63,876,000	84.0	3,500
White River	74	74	18,043,663	1,007,716	23,927	1,031,643	.....	19,075,306	9,435,694	28,511,000	66.9	910
Reelfoot	21	21	3,033,665	209,688	.....	209,688	.....	3,243,353	784,647	4,028,000	80.5	310
Upper Yazoo	97	97	41,436,756	.....	941,200	941,200	.....	42,377,956	.....	42,377,956	100.0	3,281
Lower Yazoo	206.30	185.20	60,046,984	3,431,197	.....	3,431,197	114,000	63,364,181	23,680,596	87,044,777	72.8	3,367
Upper Tensas	241	241	62,287,961	3,082,511	1,172,304	4,254,815	779,194	65,763,582	22,183,322	87,946,904	74.8	3,000
Lower Tensas	158.81	151.66	34,276,288	1,997,822	48,400	2,046,222	725,654	35,596,856	9,400,686	44,997,542	79.1	2,080
Atchafalaya	127.51	127.51	30,221,690	2,315,944	392,097	2,708,041	538,459	32,391,272	6,618,316	39,009,588	83.0	6,035
Lafourche	82.06	82.06	15,960,262	539,985	201,870	741,855	252,823	16,449,294	689,024	17,138,318	96.0	2,020
Barataria	71.98	71.98	5,421,211	160,998	11,087	172,085	129,183	5,464,113	641,750	6,105,863	89.5	
Pontchartrain	125.87	125.87	26,402,894	1,225,151	135,580	1,360,731	573,467	27,190,158	4,971,454	32,161,612	84.5	1,816
Lake Borgne	78.42	78.42	6,122,443	89,957	3,222	93,179	133,681	6,081,941	812,607	6,894,548	88.2	
Total	1,818.95	1,779	380,433,774	20,052,599	3,332,280	23,384,879	3,397,247	400,421,406	97,906,629	498,328,035	80.4	27,628

TABLE IV—MAXIMUM DISCHARGE OF GREAT MISSISSIPPI FLOODS

Location	1912 Sec.-Ft.	1913 Sec.-Ft.	1916 Sec.-Ft.	1920 Sec.-Ft.	1922 Sec.-Ft.
Mississippi River at Helena	2,041,000	1,932,000	1,706,000	1,598,000	1,612,000
Arkansas River at Little Rock	235,000	90,000	458,000	55,000	280,000
White River at Clarendon	151,000	138,000	320,000	125,000	149,000
Total above mouth of Arkansas River	2,427,000	2,160,000	2,484,000	1,778,000	2,041,000
Mississippi River at Arkansas City	2,007,000	1,782,000	1,889,000	1,513,000	1,768,000
Between Arkansas City and Trippe	(1)	138,000	336,000	5,000	(2)
Total passing latitude of Arkansas City	.....	1,920,000	2,225,000	1,518,000	1,768,000
Decrease due to reservoir effect	.....	240,000	259,000	260,000	273,000

[1] Not measured.
[2] Closed.

than 0.2 ft. at any of the regular gages from Cairo to Mhoon Landing. The stages at Helena and Sunflower Landing were respectively 0.7 and 0.6 ft. higher at the second crest than at the first, and the stages from the Mouth of White River to Vicksburg were from 0.2 to 0.3 ft. higher at the first crest than at the second. Below Vicksburg the crests were materially affected by crevasses and by the return flow of the water which had escaped through the break in the Weecama levee.

Table I shows the stages of the main tributaries above Cairo just preceding the maximum stages at Cairo for the great floods beginning with that of 1882.

In this table the date of crest at Cairo is given and the readings at other stations corresponded to these Cairo dates allowing the proper time interval for travel to Cairo; the interval in days for each station is given

TABLE V—MAXIMUM STAGES IN MISSISSIPPI REFERRED TO GULF LEVEL

	1912 Ft.	1913 Ft.	1916 Ft.	1920 Ft.	1922 Ft.
Maximum stage, feet above mean Gulf level:					
White River	165.21	164.21	165.36	161.96	165.66
Arkansas City	152.08	151.90	153.15	150.75	154.85
Difference	13.13	12.31	12.21	11.21	10.81
Slope per mile	0.292	0.274	0.271	0.249	0.240

TABLE III—PROVISIONAL MISSISSIPPI LEVEE GRADES ADOPTED IN 1914

Name of Gage Station	Miles Below Cairo	High Water of 1922 Date	High Water of 1922 Gauge Reading Feet	Previous Highest Water Height Feet	Previous Highest Water Year	High Water of 1922 Compared With Previous Highest Feet	Provisional Levee Grade Feet	High Water of 1922 Referred to Provisional Levee Grade Feet
Cairo, Ill.	0.0	Mar. 26	53.6	54.69	1913	—1.09	58.0	—4.4
Columbus, Ky.	21.6	Apr. 26	49.0	49.30	1913	— .30	52.7	—3.7
New Madrid, Mo.	71.0	Apr. 26	41.7	44.61	1913	—2.91	47.6	—5.9
Cottonwood Point, Mo.	124.5	Mar. 28–30	38.5	42.30	1913	—3.80	46.0	—7.5
Fulton, Tenn.	175.4	Apr. 29	39.2	44.07	1913	—4.87	47.0	—7.8
Memphis, Tenn.	227.0	Apr. 1, 2	42.5	46.55	1913	—4.05	51.5	—9.0
Mhoon Landing, Miss.	273.2	May 1, 2	45.1	45.28	1913	— .18	50.0	—4.9
Helena, Ark.	307.1	May 3	53.2	55.20	1913	—2.00	58.5	—5.3
Sunflower Landing, Miss.	353.7	May 2	51.0	51.60	1916	— .60	56.0	—5.0
Mouth of White River, Ark.	391.7	Apr. 21–24	56.8	56.50	1916	+ .30	61.9	—5.1
Arkansas City, Ark.	436.7	Apr. 22–27	58.1	56.40	1916	+1.70	60.5	—2.4
Greenville, Miss.	480.2	Apr. 27	52.0	50.76	1912	+1.24	55.8	—3.8
Lake Providence, La.	543.0	Apr. 27	49.6	48.80	1916	+ .80	53.7	—4.1
Vicksburg, Miss.	601.8	Apr. 28	54.8	53.85	1916	+ .95	58.0	—3.2
St. Joseph, La.	662.4	Apr. 26	52.2	50.80	1916	+1.40	54.0	—1.8
Natchez, Miss.	705.7	Apr. 26	55.3	53.50	1916	+1.80	57.5	—2.2
Red River Landing, La.	772.6	May 15, 16	55.3	53.20	1912	+2.10	57.5	—2.2
Bayou Sara, La.	806.9	May 16	49.4	47.37	1912	+2.03	51.5	—2.1
Baton Rouge, La.	841.0	May 16	45.7	43.82	1912	+1.88	48.1	—2.4
Plaquemine, La.	861.0	May 16	41.1	39.38	1912	+1.72	43.7	—2.6
Donaldsonville, La.	892.8	May 16	36.0	35.10	1912	+ .90	39.0	—3.0
College Point, La.	911.3	Apr. 27, 28	30.9	30.18	1912	+ .72	34.4	—3.5
Carrollton, La.	964.5	Apr. 25	21.3	21.05	1912	+ .25	25.2	—3.9
Fort Jackson, La.	1,046.8	Apr. 26	9.6	8.80	1916	+ .80	11.0	—1.4

TABLE VI—DURATION OF FLOODS ABOVE BANKFULL STAGE

	Gage at bank-full stage. Ft.	1882 Days	1897 Days	1903 Days	1907 Days	1912 Days	1913 Days	1916 Days	1920 Days	1922 Days
Cairo	44	63	51	21	28	48	49	66	67	62
Columbus	43	13	35	14	10	38	42	36	38	51
New Madrid	40	(1)	7	0	0	23	20	10	1	35
Cottonwood	36	53	36	19	14	39	38	36	24	48
Fulton	34	63	48	20	14	44	44	40	30	51
Memphis	34	54	51	33	29	58	59	56	50	57
Mhoon	35	47	79	51	51	66	64	70	70	66
Helena	41	85	63	77	54	63	62	65	64	62
Sunflower	36	(1)	73	84	93	86	73	97	85	72
White River	44	82	68	79	82	84	70	93	75	69
Arkansas City	44	54	54	75	75	78	65	85	73	66
Greenville	39	96	51	72	69	66	60	68	68	62
Lake Providence	37	39	60	75	88	79	71	90	73	66
Vicksburg	42	99	67	80	82	70	78	96	90	73
St. Joseph	40	97	61	72	64	70	70	85	78	69
Natchez	46	28	63	52	23	63	56	57	69	64
Red River	43	81	69	73	51	76	74	84	80	76
Baton Rouge	37	0	48	44	8	62	39	50	67	66
Donaldsonville	24	(1)	81	88	123	91	96	113	109	90
Carrollton	11	210	102	146	199	132	131	176	153	104

[1]No record.

in the heading. The day and maximum reading for each rise are given in parentheses. On the bottom line of the table, the highest known water prior to 1922 is given.

Table II shows the present condition of the levee system along the river from Rock Island, Ill., to Head of the Passes, La.; also levee operations during the past year. Under column "Estimated final contents," these estimates are based on grades and sections provisionally established by the Mississippi River Commission in April, 1914; 720.6 miles of levee have been completed to full commission grade and section.

The provisional levee grades adopted by the commission in 1914 were based upon the estimated stages for the 1912 flood confined. Table III is a tabulated statement of the maximum stages during the 1922 flood and a comparison with the previous highest records at all gage stations from Cairo to Carrollton; also a comparison of the highest stages of the 1922 flood with the 1914 provisional levee grades.

The 1922 flood stages were well below the previous highest at all gage stations above White River, but from White River to Carrollton they exceeded all previous records.

The increased height of the flood line below the Mouth of White River can be attributed only to the closure of the gap between the Arkansas River levees and the Mississippi River levees at Cypress Creek.

TABLE VII—DURATION OF FLOODS ABOVE A 50-FT. STAGE

Year	Cairo, Days	Helena, Days	Sunflower, Days	White River, Days	Arkansas City, Days	Greenville, Days	Vicksburg, Days	St. Joseph, Days	Natchez, Days	Red River Landing, Days
1882	9									
1883	14									
1884	13									
1886	8									
1890				11						
1892					1					
1893					6					
1897	19	9		30	14		37			9
1898				12	12					
1903	8	10		29	25		22		13	9
1906					1					
1907	4	5		15	16					
1909					4					
1912	22	29	11	53	49	4	10		31	47
1913	19	24	16	38	30	7	24		22	20
1916	12	19	12	43	43	11	35	10	37	35
1917				19	21					
1920	7	4		46	48		39		45	23
1922	53	45	31	55	56	36	52	33	51	53

Table IV shows maximum discharge for each of the great floods since 1912 in the Mississippi River at Helena, and Arkansas City, also the corresponding discharges for the Arkansas River at Little Rock and White River at Clarendon, allowing six days for flow from Little Rock, and two days for flow from Clarendon to Arkansas City. The discharges tabulated for Little Rock and Clarendon for the years 1912, 1913, and 1922 were scaled from discharge curves for those stations. Table IV also shows that the amount of water per second entering the basin at and above the mouth of the Arkansas River was less at the crest of the 1922 flood than at the crests of the 1912, 1913, and 1916 floods. The effect of the Arkansas and White Rivers on flood heights in the Mississippi is further illustrated by Table V, which gives the maximum stages in the Mississippi River referred to mean Gulf level, at White River, and Arkansas City; also to the total fall and the slope per mile between the two gages for all the floods included in Table IV. Table V also shows that the slope per mile was 18.4 per cent less in the flood of 1922, than it was in that of 1912. Table VI gives the gage reading corresponding to a bankfull stage at the regular gages from Cairo to Carrollton (omitting Bayou Sara and College Point), also the number of days during which the principal floods since 1882 remained above the bankfull stage at each of the gages tabulated. Incidentally this table shows that the lengths of periods of overflow have not, as a rule, been increased by levee building.

FIG. 1. FIRST AND SECOND MISSISSIPPI RIVER DISTRICTS SHOWING EXISTING LEVEES

Table VII gives the number of days during which the stage exceeded 50 ft. at the regular gages below Cairo for all the floods covered by the commission's records.

This table also shows that the duration of the stages above 50 ft. in the 1922 flood was greater than for any previous flood.

During the high water of 1922 the maximum stages at the mouth of White River, Ark., and at all gages below that point exceeded the previous highest known stages. At Red River Landing, La., the highest stage was 2.1 ft. higher than the previous highest in 1912. The highest stage at Vicksburg was 0.95 ft. above the previous highest in 1916, and was above 50 ft. on the Vicksburg gage for 52 days. Many crevasses occurred between Rock Island and Gale, Ill., none of which were through levees that were built to provisional grade and

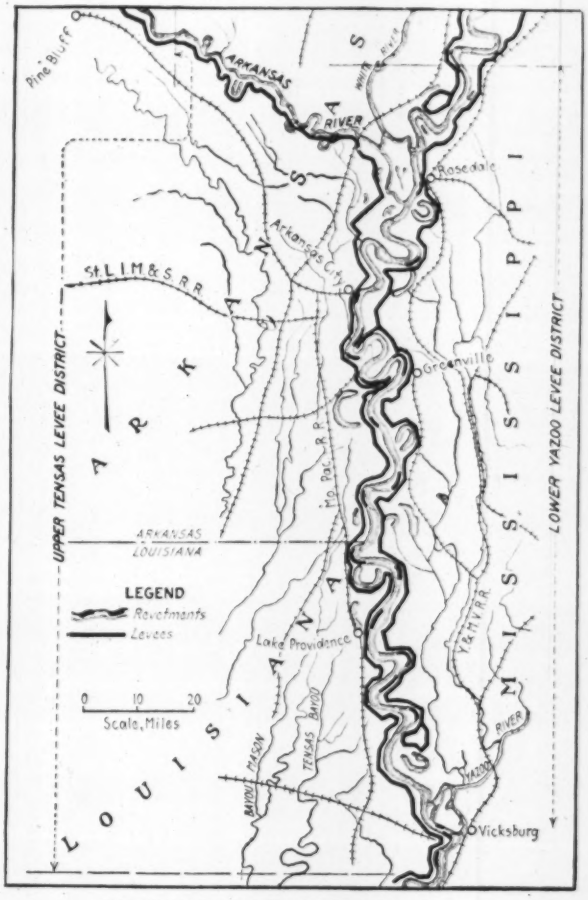


FIG. 2. THIRD MISSISSIPPI RIVER DISTRICT FROM THE WHITE RIVER TO VICKSBURG

standard cross-section. Table VIII shows the effect of the high water of 1922 on the levee system.

The maximum observed discharges at six stations on the Mississippi River from Columbus, Ky., to Carroll-

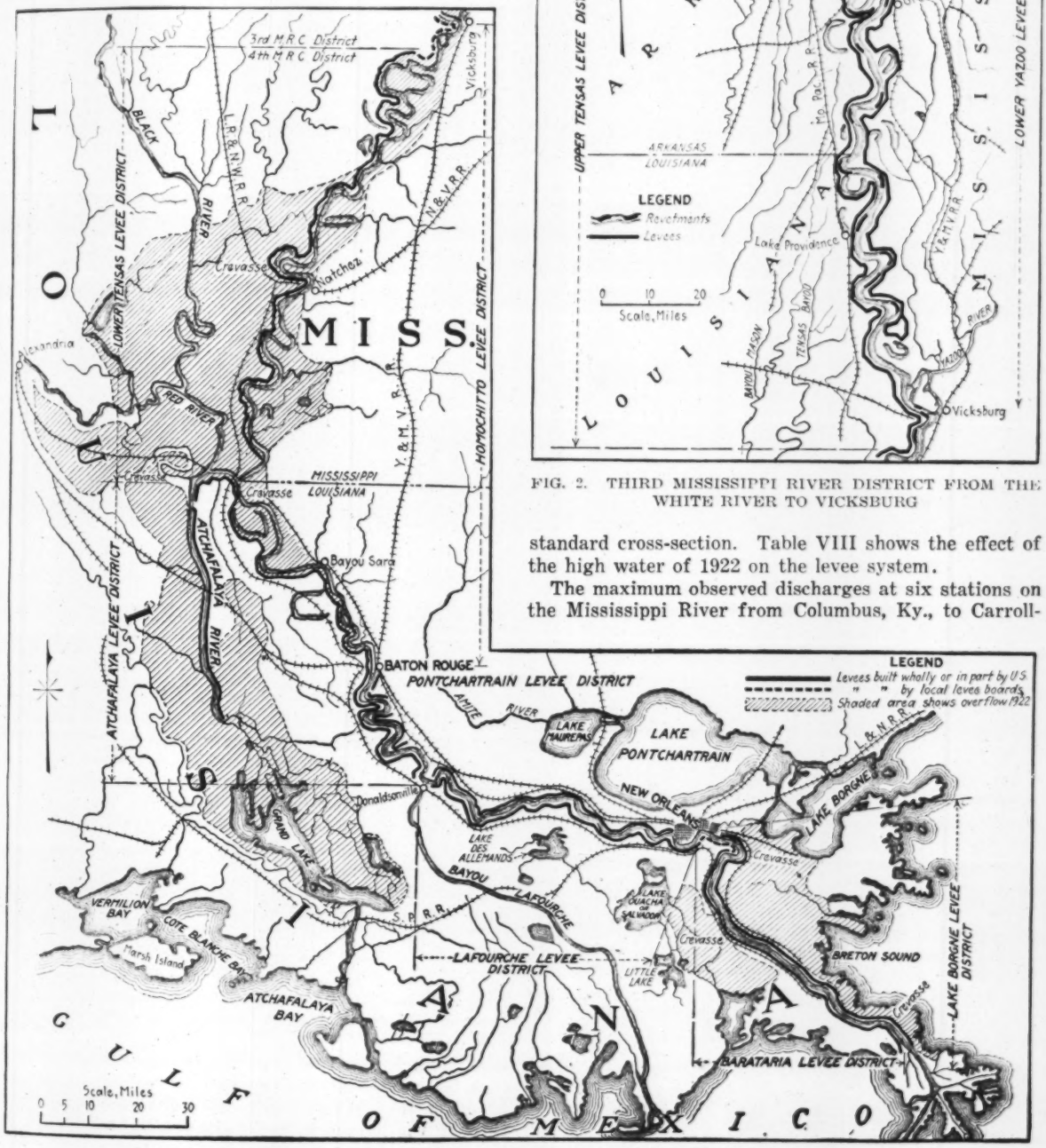


FIG. 3. THE FOURTH MISSISSIPPI RIVER DISTRICT FROM VICKSBURG TO THE PASSES

TABLE IX—MAXIMUM OBSERVED DISCHARGES ON THE MISSISSIPPI, 1858-1922

Year	Columbus, Ky. 22 Miles Below Cairo		Helena, Ark., 307 Miles Below Cairo		Arkansas City, Ark., 437 Miles Below Cairo		Vicksburg, Miss., 602 Miles Below Cairo		Red River Landing, La., 773 Miles Below Cairo		Carrollton, La., 964 Miles Below Cairo	
	Gage Ft.	Discharge Cu.Ft.	Gage Ft.	Discharge Cu.Ft.	Gage Ft.	Discharge Cu.Ft.	Gage Ft.	Discharge Cu.Ft.	Gage Ft.	Discharge Cu.Ft.	Gage Ft.	Discharge Cu.Ft.
1858	42.7	1,403,000	....	.....	....	.....	46.9	1,244,000	....	.....	....	.....
1882	43.6	1,603,000	46.5	1,562,000	....	.....	....	.....	48.3	1,595,000	....	.....
1883	....	.....	....	.....	....	.....	....	.....	....	.....	15.4	1,586,000
1884	....	.....	20.0	466,000	20.6	552,000	17.9	461,000	46.0	1,292,000	14.2	893,000
1893	43.8	1,528,000	47.5	1,594,000	50.0	1,667,000	....	.....	47.6	1,236,000	17.2	1,129,000
1897	42.5	1,462,000	49.0	1,486,000	51.4	1,646,000	52.0	1,777,000	50.2	1,290,000	18.6	1,353,000
1898	42.5	1,517,000	48.8	1,425,000	51.1	1,514,000	49.4	1,456,000	44.3	1,134,000	15.6	1,026,000
1903	44.5	1,483,000	50.9	1,686,000	50.4	1,743,000	51.4	1,614,000	50.0	1,206,154	19.0	1,337,602
1904	43.9	1,502,000	47.6	1,412,000	49.0	1,403,000	46.6	1,382,000	43.7	1,018,000	15.8	1,092,235
1907	43.2	1,543,333	49.9	1,691,170	51.9	1,608,120	49.6	1,721,211	46.9	1,291,448	18.6	1,254,852
1912	48.5	2,015,213	54.1	2,040,660	55.0	2,006,601	51.6	1,780,407	53.2	1,499,402	20.4	1,352,739
1913	49.3	2,014,849	55.0	1,931,802	55.1	1,782,084	52.2	1,783,130	50.6	1,306,364	19.2	1,125,746
1916	48.3	1,774,996	52.6	1,705,639	56.4	1,889,222	53.4	1,801,315	52.4	1,327,060	20.0	1,338,969
1920	46.9	1,527,430	50.0	1,598,080	54.0	1,513,089	50.6	1,648,798	49.6	1,109,536	17.6	1,097,074
1922	48.9	1,501,347	52.3	1,612,125	56.0	1,761,376	54.6	1,825,555	53.7	1,354,786	21.2	1,358,311

TABLE VIII—EFFECT OF FLOOD OF 1922 ON LEVEE SYSTEM

Levee District	Length Of Levee Destroyed Linear Ft.	Area of Land Overflowed Sq.Miles	Length Of Levee Protected By Sacks, Capping, Etc. Miles	Area of Land Saved From Overflow By Levees Sq.Miles
Rock Island to New Boston, Ill.	.....	.....	¼	44
Muscatine to mouth of Iowa River, Iowa	.....	.....	.....	34
Mouth of Iowa River to Burlington, Iowa	238	26	.....	34
Mouth of Des Moines River to La Grange, Mo.	100	12	.....	46
Warsaw to Quincy, Ill.	.....	.....	.....	.....
Quincy to Hamburg Bay, Ill.	.....	.....	.....	172
La Grange to mouth of Missouri River, Mo.	.....	.....	.....	50
Head of Chouteau Island to Prairie du Pont, Ill.	.....	.....	.....	96
St. Louis to Cape Girardeau, Mo.[1]	3,159	34	.....	.....
Prairie du Pont to Grand Tower, Ill.	400	31	.....	14
Grand Tower to Gale, Ill.[2]	2,457	75	.....	.....
Upper St. Francis	.....	262	.....	438
Lower St. Francis	.....	500	.....	3,000
White River	3400	[3]465	.....	445
Reelfoot	.....	.....	.....	310
Upper Yazoo	.....	.....	.....	3,281
Lower Yazoo	.....	[4]1,227	45.0	2,140
Upper Tensas	.....	.....	.....	3,000
Lower Tensas	4,500	470	28.5	1,610
Atchafalaya	.....	[5]450	49.0	5,585
Lafourche	.....	.....	57	2,020
Barataria	1,000	230	8.1	1,790
Pontchartrain	.....	.....	7.91	1,816
Lake Borgne	1,100	450	75	1,366
	13,354	4,232	.....	27,291

[1] Perry County levee districts Nos. 1, 2, and 3. These districts were protected by a levee built by local authorities which was practically overtopped throughout its entire length.

[2] Includes Preston levee district in which breaks occurred in a levee built by local authorities.

[3] Break in White River Levee. Not government levee. Laconia Circle.

[4] Includes 446 sq.mi. flooded from backwater and 19 sq.mi. flooded in Laconia Circle.

[5] Backwater.

[6] Overflowed by backwater from the Atchafalaya River.

ton, La., during the period 1858 to 1922 are shown in Table IX.

During the high water of April, 1922, crevasses occurred in a number of local levee districts between Cape Girardeau, Mo., and Rock Island, Ill. No breaks were in levees that had been constructed under supervision of the Mississippi River Commission, except in one district where the levee is claimed to have been dynamited.

High water protection of levees was carried on in a number of places along the river from Fort Jackson to Rock Island, as described in *Engineering News-Record*, May 18, 1922.

The following crevasses occurred in the levees below Cairo during the high water of 1922:

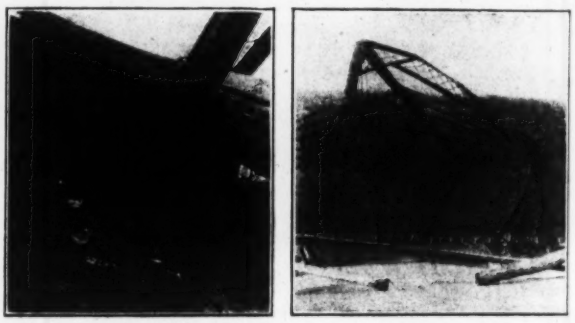
Name	Miles Below Cairo	Date of Break	Length, Ft.	Discharge Per Second Cu.Ft.	Date Measured
Weecama	693 Right	April 26		623,000	May 10
	693 Right	April 26	3,669	286,029	May 19
Poydras	985 Left	April 27	1,100	450,000	Estimated
Myrtle Grove	1,008 Right	April 22	1,000		

Automobile Pushes Bridge Off Abutment

BY CHARLES HAYDOCK
Philadelphia, Pa.

AN ILLUSTRATION of the potential destructiveness of motor cars running at high speed is found in the wrecking of a bridge near Tyrone, Pa., noted in *Engineering News-Record* of Nov. 23, p. 905.

A concrete road along the Little Juniata River between Tyrone and Altoona crosses the river on a skew of about 45 deg. by an old through Pratt bridge of seven 17-ft. panels, approached by curves of about 100 ft. radius. The inclined end posts are built up of two 7-in. channels, a 12 x ⅛-in. cover plate, and batten plates below. At 4 a.m. on Nov. 5, a Mitchell runabout failed



LITTLE JUNIATA BRIDGE AFTER CAR STRUCK POST
Curved approach responsible. One truss pushed off abutment, the end post breaking when it struck in the fall; other truss little damaged.

to make the approach and struck the outer end post. The truss was forced off the abutment, and when the end post struck the abutment or the ground it was broken and doubled back on itself, the bottom-chord members tearing away from the end pin (first view). Nearly all the members of this truss are damaged beyond repair. The portal and sway bracing are badly warped. The opposite truss, however, is in fairly good condition, only one post being seriously bent.

Prior to the accident the end pins, bearing plates, etc., were in very bad condition due to lack of maintenance. The bridge floor, of creosoted wood block, held together in the collapse except along the line of the end floorbeam, which parted from the stringers when the truss dropped. The joints between stringers and floorbeam showed considerable corrosion.

A few nights after this, another car in attempting to cross this bridge made the turn safely, crashed through the barricade, broke the red light and entered the bridge, sliding off into the river bed between two of the posts where the hand rail had been removed.

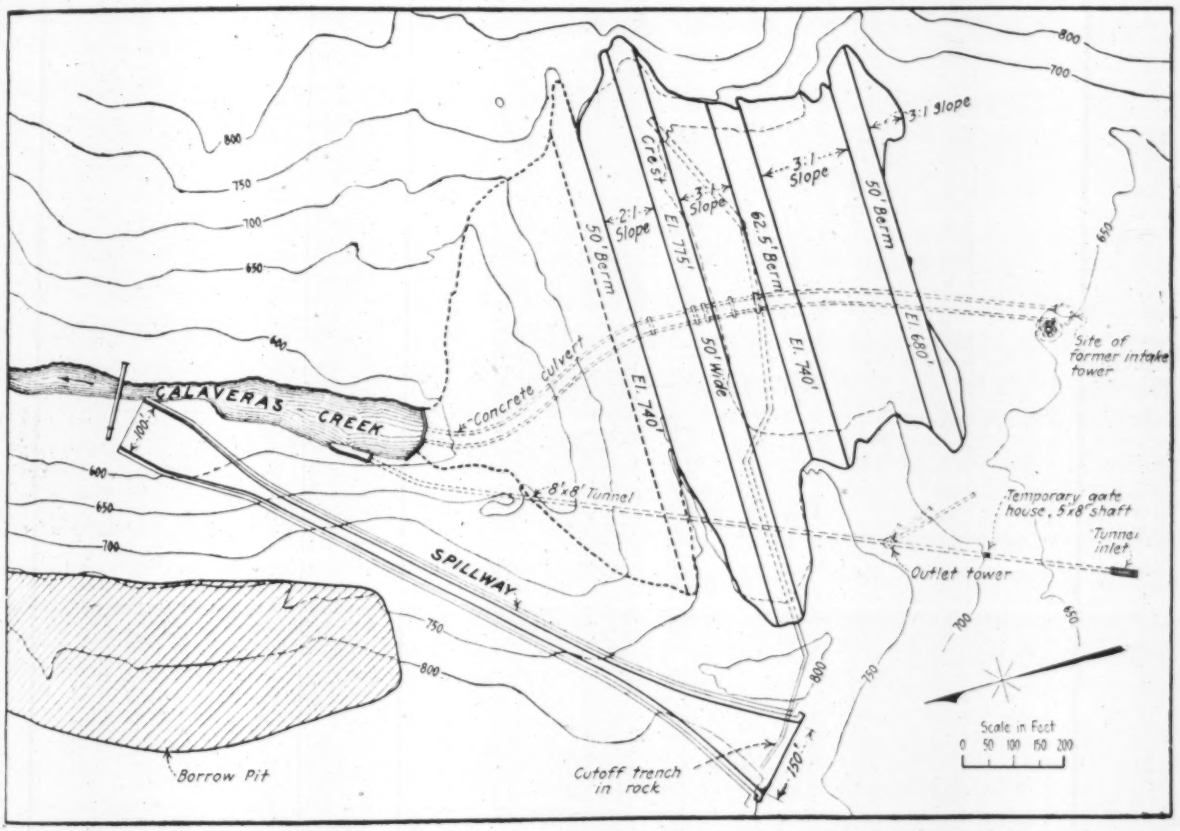
Calaveras Dam Raised With Dry Fill and Puddled Core

Additional Material Now Being Added Brings Total Height to 175 Ft.—Concrete Spillway and New Outlet Tunnel Provided

THE long deferred addition to Calaveras Dam that will bring the total height up to 175 ft., began in earnest last September when a contract was awarded to Palmer & McBryde for placing an additional 800,000 cu.yd. in the structure. The dam is owned by the Spring Valley Water Company of San Francisco and is located about 40 miles southeast of that city. In addition to the contract work the company will, with its own forces, tap into the new outlet tunnel with a shaft and a concrete intake tower above it and will also construct a concrete spillway at the west end of the dam. The accident that occurred on this dam during construction when some 800,000 cu.yd. on the upstream face slipped into the reservoir was described in *Engineering News-Record* Dec. 26, 1918, p. 1158. Plans for continuing the construction and increasing the available water supply were outlined briefly in the issues of Sept. 29, 1921, p. 540, and May 4, 1922, p. 751.

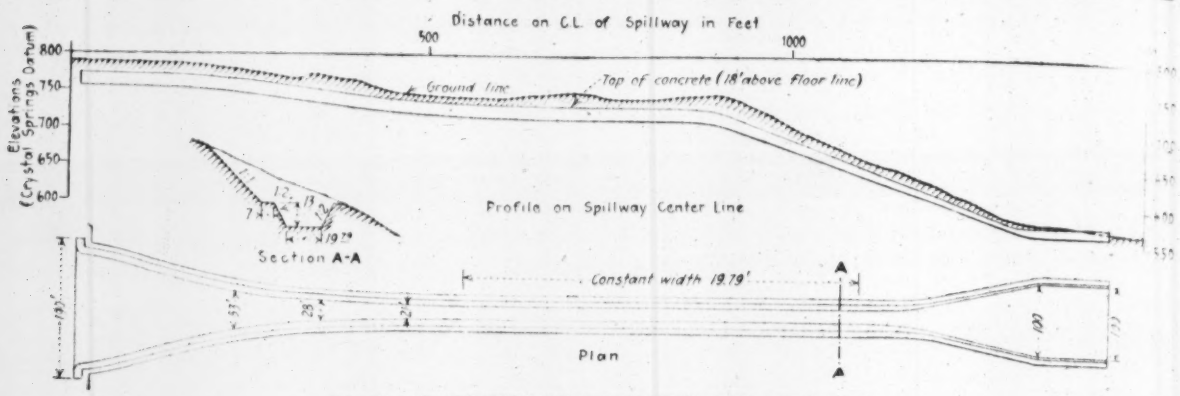
Material for the additional height is being excavated by an electrically operated shovel with a 2½-cu.yd. bucket from the west bank of the stream above the ultimate level of the crest. Delivery from this borrow pit is by 12-cu.yd. dump cars hauled by locomotive to trestles on the dam. Before the main part of this fill was started, a cut-off trench, shown in the accompanying cross-section, was excavated to hard, impervious clay. This excavation varied in depth up to a maximum of 40 ft. and represents the thickness of loose material left by the slip of 1918. Beneath this trench is material which originally was sluiced into place to form a core and which has now thoroughly solidified and hardened.

The trench for the most part follows the toe of the fill made in 1920. After filling the trench with puddled clay, a core fill of impervious clay thoroughly soaked down as the work progressed was carried up the upstream face of the 1920 fill, as shown in the cross-section. Material for filling the trench and also for making the core fill above it was taken from pockets left at the upstream toe of the dam by the 1918 slip and filled with saturated clay from the core. A good deal of this material was excavated from one large pocket whence a grab bucket loaded into dump cars at the foot of an inclined track built down the slope of the dam.



PLAN OF CALAVERAS DAM SHOWING LOCATION OF NEW OUTLET AND SPILLWAY

The section marked "sluiced core" in the accompanying drawing will be formed after the dry fills on both sides have been carried up to heights that will permit of sluicing fines by means of hydraulic giants down the faces of both fills into this central basin. If the clay and other fines that can be brought into the core by this sluicing process are insufficient, additional clay will be hauled in and dumped over the edge of the fills whence it will be carried to the desired position by the sluicing process. This plan of reconstruction is much along the lines suggested soon after the slip and described in *Engineering News-Record* Dec. 26, 1918, p. 1163. The present contract will bring the crest of the dam to El. 775 as shown in the cross-section.



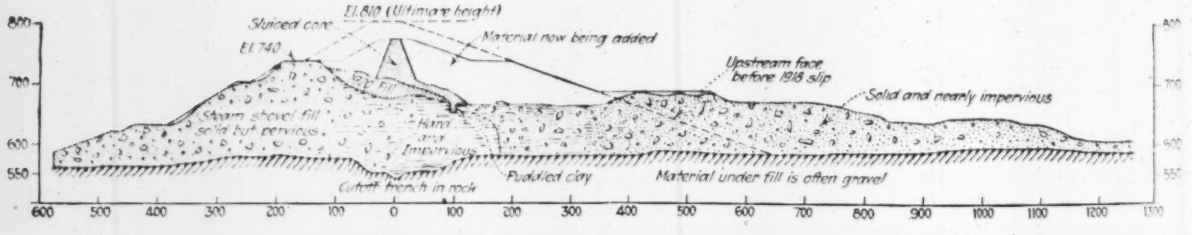
PLAN AND PROFILE OF CONCRETE-LINED SPILLWAY

After the 1918 slip the main conduit was choked with debris and the conduit marked "8 x 8-ft. tunnel" on the accompanying plan was built on rush schedule to provide an emergency relief from possible high water. This new outlet has been temporarily controlled by gate valves operated through a 5 x 8-ft. shaft. Present plans call for a concrete intake tower above ground and a shaft below ground connecting with the new tunnel, while three short tunnels will connect the shaft and reservoir at three levels below the base of the tower, thus affording means of drawing water into the outlet under all conditions of water storage.

The tower will be of standard design, 40 ft. high and 19 ft. in outside diameter at the base, with reinforced-concrete walls ranging up to 30 in. in thickness. The shaft beneath this tower will have a 42-in. concrete lining and an inside diameter of 12 ft. A novel method of mucking this shaft was made possible by the fact that the tunnel beneath it was already in service when the shaft was sunk. A 12-in. well-casing was first sunk on the center line of the shaft and the main shaft was driven around this, scraping the muck into the well as the material was broken up. The shaft traversed serpentine rock which was readily broken up. The water in the tunnel carried out the material, so the mucking process was carried on speedily at low cost.

The location chosen for the spillway was around the west end of the dam. On this side the bank has a steep slope above the top of the dam so that any considerable width of excavation would entail handling excessive quantities. To meet this situation a spillway was designed with a capacity of 20,000 sec.-ft. which will have, through the major portion of its length, constant depth and varying width. The desired capacity will be secured by using a wide intake which narrows and pitches down on a sharp grade as it approaches the slope of the hill where a minimum width is desirable to reduce the necessary excavation. The grade will be as much as 35 ft. per hundred toward the lower end and velocities will range from about 2½ ft. per second at the intake to 97½ ft. per second in the "chute" or lower section. The discharge from the spillway will be into a spillway pool, however, from which the flow is not to exceed about 12 ft. per second.

The work on Calaveras Dam is now being done under the direction of George A. Elliott, chief engineer, and T. W. Espy, construction engineer, of the Spring Valley Water Co., from whom the data were obtained.



CROSS-SECTION OF CALAVERAS DAM SHOWING NEW WORK

Municipal Coal and Wood Yard Legal in Minnesota

The Minnesota Supreme Court (Central Lumber Co. *vs.* City of Waseca *et al.*, 188 Northwestern Reporter; 275) has decided that the establishment of a municipal fuel yard and a tax levy for its operation is constitutional. The decision, in part, is as follows:

The question is whether the establishment of a municipal coal and wood yard is a public purpose. The constitutional validity of the charter is presumed. It is to be assumed that in framing their charter the people were informed of conditions, such as the sources of supply, the ability and disposition of dealers to care for local demands, and other relevant factors affecting the situation, and found that public necessities and conveniences were such that the establishment of a municipal fuel yard was a public purpose. They have the responsibility of their finding and the wisdom or folly of the policy which they authorize. Their determination of public purpose is not final. It is accorded weight, but finally the court must determine as a judicial question whether the purpose for which taxes are exacted is public.

Economic and industrial conditions are not stable. Times change. Many municipal activities, the propriety of which is not now questioned, were at one time thought, and rightly enough so, of a private character. The constitutional provision that taxes can be levied only for public purposes remains, but conditions which go to make a purpose public change.

In our judgment the establishment of a municipal fuel yard is a public purpose.

Microbiology and Theory of Activated Sludge

Discussion of Colloidal vs. Biological Explanation of Phenomenon—Counts of Micro-Organisms Made to Determine Effective Surface

By Dr. A. M. Buswell and H. L. Long
Chief and Assistant Biologist, respectively, Illinois State Water Survey, Urbana, Ill.

IN REVIEWING the expressions of opinion with regard to the theory underlying the activated-sludge process of sewage disposal one comes to the conclusion that two main lines of action are held responsible for the results obtained. That the mechanism of the reaction is sometimes described as that of adsorption of the colloidally dispersed matter by sludge already present in the sewage is evident from the following statement quoted from well known authorities.[1]

"The sludge embodied in sewage and consisting of suspended organic solids, including those of a colloidal nature when agitated with air for a sufficient period, assumes a flocculent appearance very similar to small pieces of sponge. Aerobic and facultative aerobic bacteria gather in these flocculi in immense numbers, some having been strained from the sewage and others having developed by natural growth."

In other words, the usual suspended particles in sewage grow by the accretion of material colloidally dispersed, thus producing activated sludge. Other writers refer to the "scrubbing action" of suspended particles and compare the action of activated sludge to that of coagulated alum.[2] The process is often referred to as one of oxidation, assuming that oxidation is a necessary step in the purification of sewage. Another definition states that activated sludge must be of "a character to absorb colloidal matter," and still another author[3] refers to the "clotting" of the colloids in the sewage. Such expressions seem to indicate what might be called the colloidal or mechanical theory for the mechanism of the action of activated sludge, similar in many respects to the Hampton doctrine of the action of sewage filters.

The other theory which one meets, and which in reality seems to have been the first to be proposed, is what might be called the biological theory and resembles Dunbar's theory of sewage filters. Those emphasizing this viewpoint of the action of activated sludge call attention to the analogy[4] between the action of slate beds, contact beds and sprinkling filters and the action of activated sludge. The sludge is referred to by these writers, not as a clotted, agglomerated or coagulated sludge produced by the mechanical growths of suspended particles in the sewage, but as biological growths arising from the germination and propagation of micro-organisms whose spores are always present in sewage. The term "cultivated sludge"[5] used by one author contrasts perhaps as strongly as any with the term "coagulated" or "agglomerated" sludge, used by those favoring the colloidal theory.

Of the authors who favor the biological theory, we find that some[6] refer to nitrification and nitrifying organisms as requisites for the success of this method of sewage treatment, while others refer to the sludge as being composed of a variety of micro-organisms. Mumford's[7] *M7* seems to have been the only specific organism mentioned as having ability to produce the purification of sewage. This organism, it will be remembered, required for its best activity appreciable amounts of iron.

If one examines particles of activated sludge under the microscope he is immediately impressed with the fact that there is practically no adsorbed, precipitated or coagulated amorphous matter in these sludge particles, but that they are composed entirely of active growing microscopic organisms of varieties ranging from true bacteria up through the giant bacteria, with occasionally moulds and yeasts, and including, as well, a variety of free swimming and attached protozoa[8]. These communities of micro-organisms must obtain food and this food must be supplied from the colloidal organic matter in the sewage. From what we know of the metabolism of micro-organisms it is probable that the unicellular forms are absorbing through their membrane such soluble forms of organic matter as are able to pass through this membrane, and that they are also secreting enzymes which are capable of peptizing or liquifying colloidal particles too large to be directly absorbed. Protozoa, on the other hand, can easily be seen to approach and ingest visible particles of organic matter.

Action Like Hog Feeding—This biological theory of the action of activated sludge might be summarized and emphasized by proposing what seems to be a rather striking analogy, namely, that the purification of sewage effected by microscopic communities appearing as flocs is entirely similar to that of garbage disposal by feeding it to hogs. It does not seem probable that colloidal or mechanical precipitation play any greater part in the metabolism of micro-organisms than they do in the digestion of the larger animals. One serious objection to the colloidal theory of coagulation is that the colloidal particles in sewage and the activated-sludge particles are, so far as we are able to determine, both negatively charged. Since adsorption of colloids is most effective between oppositely charged particles it should not be applied to the conditions of the activated-sludge particles without reservation.

Discussion of the theory at this time may seem academic and impractical. Since, however, these two theories would suggest rather different lines of attack on the general problem, we have chosen to review and compare them.

If the action is largely colloidal and mechanical, then we will need to study particularly the colloid chemistry of the sewage. If, on the other hand, it is biological, we will need to study the biology of the sludge, and should have for the sake of the success of the activated-sludge process a most complete knowledge of the desirable and undesirable members of these microbial communities upon which we are to rely for the purification of sewage.

Comparatively little has been published on the organisms of activated sludge. Earlier writers make especial mention of nitrifying bacteria. Bartow[9] and Smith noticed large numbers of worms (Aeolosoma Hemprichii) as well as Vorticella and Rotifera at times in the sludge. Purdy[8] counted the various protozoa in strawboard waste activated in a 3-in. glass tube and fed by the fill-and-draw method.

More recently Dienert[10] and Cambier[11] have debated the role of bacteria in the activated-sludge process. Dienert maintains that bacteria are essential since nitrification did not take place in the presence of phenol. Cambier, on the other hand, maintains that the activated-sludge process is an example of ordinary chemical catalysis. His conclusions appear to be based on three experiments: One in which chloroform was introduced with the air used for aeration, apparently on the assumption that the chloroform would be a germicide; one carried out at low temperature (0 to 12 deg. C.) on the assumption that nitrifying bacteria are not active at these temperatures, and one in which iron sulphide was added. That nitrification and purification were accomplished under these conditions Cambier interprets as proof of the catalysis theory of the reaction. He presents no definite data to show sterility of his solutions. In the same journal Courmont[12] reports a study of the

A brief abstract of this paper and the new definition of activated-sludge ventured were presented by Dr. Buswell to the Philadelphia Convention of the American Water Works Association.

PROCESSION OF ORGANISMS AND SOLIDS FROM RAW TO MATURED ACTIVATED SLUDGE

Dorr-Peck Tank I

Date	Minute Ciliates and Flagellates	Peritrichia	Holotrichia and Heterotrichia	Hypotrichia†	Larger Flagellates	Nematoda	Beggiatoa Filaments	Standard Units Zoögleal Masses Millions per c.c.	Total Solids Mg/l	Per Cent Solids by Volume, 1 hr. sed.
1921										
Nov.				(Thousand per c.c.)						
17	2,885.0	.10	.30					.11		
18	215.0	.30	1.40				.20	.38	2,200	5
19	90.0	.60	1.90				.30	.37	2,700	7
20										7
21	17.5	3.70	2.40			.10	.10	.48	2,930	8
22	+	6.70	1.60			.20	.30	.77	3,370	9
23	+	2.70	1.40			.20	.60	.49	4,030	11
24										13
25	+	8.60	3.60	1.20		.10	.30	1.08	4,500	15
26	+	14.07*	1.00	1.00		.50	.33	.54	4,900	18
27										29
28	+	6.50	3.00	3.80		.70	.40	.10	5,300	37
29	+	12.85*	6.40	1.80		1.00	.80	1.54	5,800	48
30	+	8.00	6.40	2.40		1.60	.40	1.81	5,430	68
Dec.										
1	+	17.10	5.70	3.30		1.80	.60	2.06	6,140	76
2	+	1.44	5.40	3.60		2.40	.90	2.50	7,350	78
3	+	14.70	5.40	4.50		2.40	1.50	2.56	6,480	84
4										82
5	+	4.00	.60	.80		1.00	.40	1.11	6,050	78
6	.....	3.00	4.80	2.70		3.30	1.20	1.70		
7	.....	5.00	2.00	2.50		1.50	2.00	1.51	5,300	75
8	.....	6.50	2.00	2.00	5.00	1.50	1.00	2.40	4,800	74
9	.....	4.00	2.50	1.00	5.00	1.50	4.00	1.71	4,410	74
10	.....	6.80	1.60	1.60		2.00	1.20	1.24	4,100	52
11	.....									64
12	+	7.60	1.20	3.20	4.20	4.00	2.80	2.10	4,270	56
13	.....	12.00	2.20	4.00			4.50	1.84	4,260	57
14	.....	15.00*		2.00	10.00	1.00	3.00	1.56	3,770	57
15	+	13.00		3.00		.50	5.00	1.99	4,010	59
16	+	5.00	1.00	.50	5.00	1.00	5.50	1.55	3,120	58
17	+	1.60					.80	.82	3,060	55
18	.....									60
19	+	6.00		1.60		.80	3.20	1.41	3,180	54
20	+	5.20	.40	1.60			4.40	1.32	2,910	56
21	+	4.80		.40			1.20	.82	2,660	62
22	+	5.10		.60			3.00	.79	2,450	54
23	+	2.40	.40	.40			1.60	.51	2,640	64
24	+	5.00	.40	2.60			.80	.71	2,800	67
25	.....									63
26	+	17.00*	.50	1.50			.50	2.39	3,650	70
27	+	10.8	1.00	2.60		.20		.89	3,820	61
28	+	12.40*	.60	1.80		.40	.40	1.10	.....	81

Dorr-Peck Tank II

Nov.										
17	.....	.....	.....	.....	.....	.....	.....	.....	.....	..
18	120.0	.....	.30	.....	.....	.10	.....	.043	1,370	1
19	63.0	.60	.50	.....	.....	.....	.20	.098	2,360	2
20										2
21	75.0	1.50	.70	.....	.....	.....	.20	.224	1,390	2
22	12.5	2.90	.80	.10	.....	.....	.30	.132	1,410	3
23										2
24	+	1.10	.40				.20	.231	1,370	3
25	+	.10	1.10	..		.30	.40	.205	1,120	2
26										2
27	.....	.90	.80	.20	.....	.10	.20	.185	1,220	2
28	+	1.20	.50	.20	.....	.10	.10	.145	1,050	2
29	+	.50	1.00	.....	.....	.10	.10	.055	900	1
30	+	.50	.30	.10	.....	.10	.30	.119	870	0
Dec.										
1	+	.60	.10	.....	.....	.....	.....	.024	890	..
2	+	.10	.40	.....	.....	.10	.....	.026	780	..
3									790	..
4	.....	.....	.....	.....	.....	.....	.....	.....		
5	.....	.....	.....	.....	.....	.....	.....	.....	1,160	4
6	.....	5.10	.60	.90	.....	.90	.....	.725		27
7	.....	8.00	40	2.40	.....	1.20	40	1.270	3,970	60
8	.....	3.80	70	1.30	.....	.40	10	1.912	4,570	64
9	.....	4.10	70	40	.....	.90	20	.540	4,610	62
10										74
11	+	2.80	30	.70	.....	.40	50	.312	4,780	60
12	+	13.20	40	2.40	.....	2.40	2.40	2.010	4,460	70
13	+	16.00	7.50	5.50	.....	3.00	2.50	3.400	4,630	75
14	+	16.50	50	2.50	.....	2.50	3.50	2.012	4,550	75
15	+	9.50	50	5.00	.....	2.50	1.50	1.987	3,990	69
16	+	9.00			.....	1.50	3.00	1.712	4,030	75
17	+	7.60	40	40	.....	.80	5.60	1.500	3,450	82
18										82
19	+	6.00	80	5.60	.....	.40	1.20	1.170	3,610	86
20	+	12.4	40	2.00	.....		4.40	2.530	3,610	88
21	+	12.40		3.60	.....	.40	2.80	2.300	3,530	92
22	+	15.00	.90	1.20	.....	.90	3.90	1.192	3,270	83
23	+	10.40		.80	.....	.....	2.60	.840	3,000	92
24	+	4.80		.40	.....	.....	2.00	.675	2,690	89
25										99
26	+	3.80	2.20	2.00	.....	.20	.20	1.025	3,570	90
27	+	4.80	1.80	2.40	.....	.....	.20	1.170	3,570	88
28	+	6.40	.80	.80	.....	.....	.20	1.405	.....	87

* Colony or cluster of peritrichs present.

† The standard unit is used here as a measure of surface only and = 0.004 mm. sq.

bacterial flora of activated-sludge effluent. He found seven species, one of which was B. subtilis. No obligatory anaerobes were found and in some cases B. coli was absent.

Of the various investigations which have been made that of Purdy* furnishes the most complete data on the various organisms present in the sludge. Purdy followed the usual Sedgwick-Rafter method of enumerating the microscopic organisms, reporting the zoögleal flocs in standard units of 0.004 mm. sq. Purdy used a 500 c.c. aerating vessel operated with an unmeasured excess of air on the fill-and-draw system with 24-hour aeration periods. This system served admirably the purposes of the particular investigation which showed the presence of relatively large numbers of protozoa, especially of Peritrichs. Some work of the present authors on a similar scale, and with excess of air and 24-hour fillings, gave similar results. They do not seem to correspond to results obtained when smaller amounts of air are used, nor with the results on larger experimental units.

The analytical data herewith reported refer to samples taken from the aeration chambers of a two-tank Dorr-Peck activated-sludge unit fully described elsewhere.[†] For the purposes of the present paper it will be sufficient to state that the apparatus was treating about 65,000 gal. a day in two aeration chambers having capacities of 14,400 and 12,700 gal. respectively and operated in series. Approximately 0.75 cu.ft. of air was used per gallon of which two-thirds was used in the first tank and one-third in the second. A good degree of clarification and an average methylene-blue stability of three days were obtained during the run.

Microscopic observation made during the winter of 1920-21 indicated some sort of a relation between the amount of air used, the strength of the sewage, the settling rate of the sludge and the types of organisms composing the sludge. When in the spring after a shut-down for repairs, the plant was started up without any activated-sludge as a "starter," daily microscopic observations were made to follow the changes in microbial life as the sludge built up. The daily records, which on account of the unexpected pressure of other work had to be limited to brief observations, are given below. In general it is to be noted that the Holotrichs were the first to appear in noticeable numbers but that they gave way in time to other forms. The Peritrichs (Carchesium and Vorticella) appeared only after several days of aeration. The matured sludge seemed to be composed largely of zoögleal masses with frequent colonies of Peritrichs and an occasional Hypotrich (generally Euplotes).

In September the daily qualitative study of the sludge was resumed and a careful investigation of the forms in the zoögleal masses undertaken. In November an interruption in the operation of the plant offered another opportunity to study the forms appearing during the building up of sludge. In this series of examinations, which dates from Nov. 17, quantitative estimations were made using the Sedgwick-Rafter method of enumeration, as Purdy did. Beginning with Dec. 9, $FeSO_4$ equivalent to 10 mg. per liter of Fe, was added to the influent sewage for the purpose of determining its effect on the nitrogen cycle. It appeared to be without effect on the character of the organisms found. The results of these examinations are given in the accompanying table.

In the study of the microbiology of activated sludge in its development from raw sewage there seems to be a definite succession or addition of forms, as the sludge develops. Beginning with the characteristic micro-organisms of raw sewage as it is taken into the aeration chamber, there is a predominance of the minute flagellates and ciliates, with occasional Peritrichs and Holotrichs. In a few days the minute forms diminish in number until they become a negligible quantity while Peritrichs, Holotrichs and Heterotrichs increase in number, the Peritrichs predominating throughout. As the minute forms become insignificant the zoögleal masses of the Chlamydobacteriacae and Nematodes appear, to be followed in a few days by the sudden appearance of Phyotrichs. This point then brings us to the characteristic fauna and flora of the matured activated sludge, under the particular conditions of operation employed, e.g.—aeration, rate of filling and drawing, etc.

SUMMARY OF MICROSCOPIC OBSERVATIONS MAY 3-17, 1921 DURING BUILDING-UP PERIOD OF ACTIVATED-SLUDGE TANKS I AND II

May 3	Plant started operation.
May 4	I. A few Paramecium, paper fibers and miscellaneous vegetable cells.
May 5	I. Paramecium, paper fibers and miscellaneous vegetable cells. II. Zoögleal masses of fine bacterial filaments beginning to form.
May 6	I. Large flocs of zoögleal masses of fine bacterial filaments. II. Zoöglea, Paramecium, Colpidium.
May 7	I. Branching zoögleal masses of fine bacterial filaments, Paramecium, Spyrogyra. II. Paper fibers with much attached zoöglea. Many Paramecium, few Peritrichs (Vorticellidae), branched zoögleal masses of fine filaments.
May 8	I. Branched zoögleal masses of fine filaments, Paramecium, Colpidium, one filament of Spyrogyra. II. Branched zoögleal masses of fine bacterial filaments, few Holotrichs, mould hyphae and paper fibers.
May 9	I. First appearance of Peritrichs in tank I. One filament of Spyrogyra, Zoögleal masses of filamentous bacteria. II. Increase in Peritrichs.
May 10	I. Few ciliates, 80 per cent of field consists of zoögleal masses. II. Many Peritrichs.
	I. Largely zoögleal mass of filamentous bacteria; some Hypotrichs and Peritrichs. II. Largely zoögleal masses of filamentous bacteria; fewer Peritrichs.
May 12	No change in character.
May 13	Increase in Peritrichs.
May 15, 16, 17	No changes in character.

Bacterial Surface—Hering[14] long ago pointed out the importance of bacterial surface in sewage purification, though little definite data have been developed since his paper on the subject. From the tables we may obtain a notion of the order of magnitude at least of the sludge surface in the activated-sludge process. Take a case where 2,000,000 standard units of zoögleal masses were found per cubic centimeter in the aeration chamber. Each floc must have a lower surface equal at least to the upper surface estimated so that leaving out the side surfaces we would have 4,000,000 standard units of 0.004 mm. sq. each or 160 c.m. square of surface per cubic centimeter of volume. This figure does not include the surface of the protozoa or the free-swimming bacteria. If increased by 50 or 100 per cent it would probably approach more closely the correct value.

Summary—In view of previous work of other authors cited and the data of the present paper we wish to propose the following statement of the theory of the activated-sludge process: Activated-sludge flocs are composed of a *synthetic* gelatinous matrix, similar to that of Nostoc or Merismopedia, in which filamentous and unicellular bacteria are imbedded and on which various protozoa and some metazoa crawl and feed. The purification is accomplished by digestion and assimilation, by organisms of the organic matter in the sewage and its resynthesis into the living material of the flocs. This process changes organic matter from colloidal and dissolved states of dispersion to a state in which it will settle out.

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Monuments to Early Engineers of the Rock Island Ry.

Samuel B. Reed and Gen. Grenville M. Dodge Are Honored for Location and Construction Work on Pioneer Lines

IN THE recent celebration of the 70th anniversary of the Chicago, Rock Island & Pacific Ry., whose first train was run from Chicago to Joliet in 1852, a pleasant feature was the unveiling of monuments erected by the railway company in memory of two engineers who were engaged in the survey and construction of the early lines of the Rock Island system, which were pioneer lines in the development of the western part of the country. These engineers were Samuel B. Reed and General Grenville M. Dodge, both of whom were later prominent in the location and construction of the Union Pacific as the final link in the first transcontinental railway. Both became members of the American Society of Civil Engineers.

FIG. 1—SAMUEL B. REED
First location and construction engineer, Rock Island System

The Rock Island System—The beginning of the present system known as the Rock Island Lines was the incorporation in 1847 of the Rock Island & La Salle R.R., to connect navigation on the Illinois and Mississippi rivers. Later it was authorized to extend east to Chicago. Construction was commenced at that point, the track being laid with rails brought from England and delivered by lake schooners. On Oct. 10, 1852, the first train was run from Chicago to Joliet, 40 miles, thus inaugurating the new railway. In June, 1854, the first train was run from Chicago to Rock Island, on the Mississippi.

The Mississippi & Missouri Ry. was incorporated in 1853 to build westward across Iowa to the Missouri River, the city of Council Bluffs being selected as the

terminal of this road and the place for the crossing of the projected line to the Pacific. But, the railway did not reach Council Bluffs until 1869. The great timber truss bridge over the Mississippi to connect the two lines was a remarkable engineering work but was the subject of strong protest by the steamboat interests. In a case where the wreck of a steamboat was

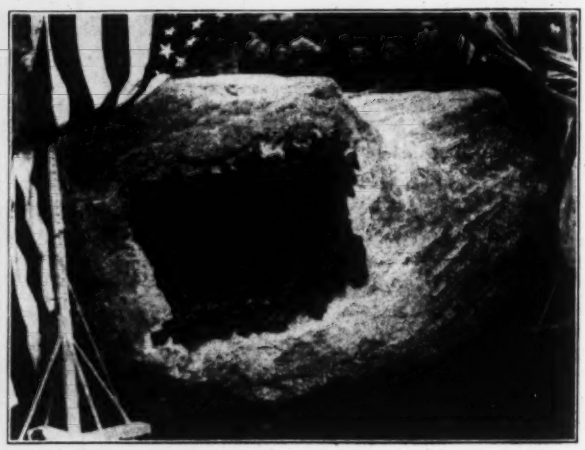

FIG. 2—MONUMENT TO SAMUEL B. REED AT JOLIET

charged to the new bridge Abraham Lincoln was attorney for the railway. Besides a swing span of 285 ft. there were five fixed spans of 250 ft. The noted engineer, John B. Jervis, was consulting engineer for both of these railways, which on completion formed a line from the Great Lakes to the Missouri River. At present the system of the Chicago, Rock Island & Pacific Ry. aggregates more than 8,000 miles.

Samuel B. Reed—Mr. Reed was born at Arlington, Vt., in 1819 and was educated at Middleport Academy. His engineering experience began in 1841 on the enlargement of the Erie Canal, following which he was with the Detroit & Pontiac Ry. until its completion in 1843, when he joined the U. S. Government expedition which explored the upper Lake Superior country. In 1846 he took charge of the extension of the Michigan Central R.R. west from Kalamazoo to Mattewan, and when that was finished he went with the Michigan Southern & Northern Indiana R.R. This latter was completed in 1852 and was the first railway to enter Chicago from the east.

In 1850, Mr. Reed was engaged as engineer for the Rock Island Ry. and then made the survey from Chicago to Joliet, the first section of the line. He was in charge of construction of the entire main line from Chicago to the Mississippi, with the exception of a few miles, and on its completion he surveyed the Washington branch, which is now a part of the Kansas City line of the Rock Island System. Later he went to the Chicago, Burlington & Quincy R.R.

In April, 1864, Mr. Dey, chief engineer of the Union Pacific R.R., appointed Mr. Reed as locating engineer for that part of the line from Green River, Wyo., to the Salt Lake basin. He reached Salt Lake City by stage in May and began his exploration of possible passes through the mountains, reporting in 1865 in favor of the Wasatch, Echo Canyon and Weber River route. He was superintendent of construction from February, 1866, to May, 1869, when connection was completed with the Central Pacific.

In later years Mr. Reed was employed on various railway works and was engaged by Mr. (later Sir) William C. Van Horne to report on the proposed western end of the Canadian Pacific Ry. He died at Joliet, Ill., on Dec. 25, 1891. A portrait of Mr. Reed is reproduced in Fig. 1. In Fig. 2 is shown the monument which was erected to him by the Chicago, Rock Island & Pacific Ry., and which was unveiled on Oct. 10, 1922.

General Grenville M. Dodge—In 1831, Grenville M. Dodge was born at Danvers, Mass. He entered Norwich University at Northfield, Vt., in 1848 and after graduating from the scientific department early in 1851 he entered Capt. Partridge's private school for practical instruction in field engineering, receiving a diploma as a military and civil engineer in July, 1851. He went west at once, to Peru, Ill., and was axeman and transitman on the surveys for the Illinois Central R.R. from La Salle to Bloomington. In March, 1852, he was engaged as rodman by Peter A. Dey, division engineer of the Rock Island R.R., and later had charge of the survey of the Peoria branch. When Mr. Dey was made chief engineer of the Mississippi & Missouri R.R., as an extension of the Rock Island Ry., he engaged Mr. Dodge as principal assistant engineer in the survey of a line between the two rivers. The route selected was from Davenport, through Des Moines to Council Bluffs, this last point being selected as the Missouri River crossing for the future Union Pacific R.R. Until 1857 he was engaged in the construction of the Mississippi & Missouri Ry., which is now a part of the Rock Island System. Construction being then suspended he continued the surveys west of the Missouri for the Union Pacific.

During the Civil War, General Dodge had extensive experience in reconstructing railways and bridges de-

FIG. 3—MONUMENT TO GEN. GRENVILLE M. DODGE AT NORWICH UNIVERSITY, NORTHFIELD, VT.

stroyed by the Confederate army. Meanwhile work on the Union Pacific R.R. had been commenced at Omaha, in 1863, and on his resignation from the army in 1866, with the rank of Major-General, he became chief engineer of this pioneer line to complete the first trans-

continental railway. Under military protection against numerous attacks by the Indians, the surveys were extended to the California state line and construction was carried on until in May, 1869, it met the Central Pacific, building eastward. These surveys are said to have included some 15,000 miles of instrument line and 25,000 miles of reconnoissance.

Plans for a Missouri River bridge connecting Council Bluffs and Omaha were prepared by General Dodge in 1868, and he is said to have been responsible for the use of the pneumatic process in sinking 9-ft. cylinder piers to a depth of 60 to 90 ft. in the loose sand of the river bed. These depths are also said to have been about twice as great as those of previous foundations sunk by the pneumatic process in this country.

For the next 25 years, 1870-1895, General Dodge was active in railway construction, largely in the West and Southwest. He retired in 1896 and died in 1916 after a life of prominence in the railway and engineering development of the "Wild West." More complete records of his career are given in *Engineering News* of Jan. 20, 1916, and Oct. 28, 1909.

As part of the Rock Island Ry. celebration on Oct. 10, 1922, monuments to General Dodge were erected at Council Bluffs, Ia., and at Norwich University, the latter is shown in Fig. 3. A seat will be built later on the slab which supports the granite block. The spade shown was used in digging the hole for the memorial tree.

Transmountain Diversion of Water in Colorado

Need and Extent of Diversions Already Made—Physical Limitations—Colorado River Problem and Denver Water Supply

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THE plan of the seven Western States through a commission and the Federal Power Commission to divide equitably the waters of that river and the fact that the bulk of the water originates in Colorado, makes transmountain diversion of water in that state an important subject to the engineering profession. To show the need for transmountain diversions, the extent to which such diversions have already been made, both from the Colorado and other mountain drainage basins, the physical limits of such diversions from the Colorado River basin, and the effect of these latter upon the flow of the Colorado at the state line, the following article is presented. The physical limitation of transmountain diversions from the Colorado River in Colorado appears to be less than 300,000 acre-ft. annually, and the effect of these will reduce the flow at the state line by only a few per cent.

More than half of the 103,658 sq.mi. comprising the area in Colorado are within the Rock Mountain region. The eastern part of the state lies within the province of the great plains which extend from the front range of the Rockies to the Missouri River. Irrigation has been practiced in this region for many years, and the area of irrigable land is only limited by the water supply. The sources of this supply are the South Platte and Arkansas rivers and their numerous tributaries which rise on the eastern slope of the Rocky Mountains. With the present water supply the limit of irrigation on the plains has been almost reached. On the western slope of the mountains, particularly in the Colorado River

PRINCIPAL STREAMS, TRANSMOUNTAIN DIVERSION
Continental Divide in relation to Denver also shown

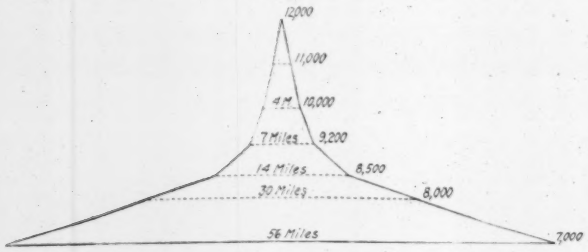
TABLE I—EXISTING TRANSMOUNTAIN DIVERSIONS IN COLORADO

First used	Ditch	Diversion From	Diversion To	Conduit Tunnel Miles	Conduit Ditch Miles	Conduit Capacity Sec.-Ft.	Drainage Area Intercepted Sq.Mi.	Average Annual Diversion Acre-ft.
		North Platte River basin:						
1899	Skyline	Laramie River	Cache la Poudre	0	5	130	17	17,000
1902	Sand Creek system	Headwaters of Laramie River	do	0	3	100	10	2,990
1914	Laramie-Poudre tunnel	Laramie River	do	2	9	800	60	5,900*
1919	Bob Creek	Headwaters of Laramie River	do	0	2	..	1	100
1905	Rist and McNab	Headwaters of North Platte	do	0	2.5	50	4	3,060
	Cameron Pass	do	do	0	2	10	..	300
		Colorado River basin:						
1903	Grand River	North Fork Colorado River	Cache la Poudre	0	8	220	12	12,400
	Ewing	Eagle	Arkansas River	0	2	18	2	2,200
1910	Berthoud	Fraser	Clear Creek	.087	4	53	4	600
1914	Boreas Pass	Blue	South Platte	0	1	10	..	400
1914	Cochetopa	Cochetopa Creek	Rio Grande	0	2	40	10	2,500
								47,400

* Laramie-Poudre tunnel is limited to an annual diversion of 15,500 acre-ft. by a recent decision of the United States Supreme Court in the Wyoming-Colorado suit. The drainage area intercepted by it includes that intercepted by the Skyline and Sand Creek systems which divert water at higher elevations.

basin, which includes all of the mountainous area except 7,700 sq.mi. in the Rio Grande basin and 1,730 sq.mi. in the North Platte basin, the water supply is far in excess of the irrigable land.

For many years water has been diverted from the Colorado and North Platte drainage basins by means



TUNNEL LENGTHS INCREASE AS ELEVATION FALLS
Section through mountain range on headwaters of Fraser River.

of open ditches. Table I gives the principal facts of each existing transmountain diversion.

These diversions are made chiefly by open ditch and represent practically the limit of transmountain diversion by that relatively inexpensive means.

The continued need for additional water on the eastern slope of the Rockies has caused water users to propose additional diversions of greater magnitude and cost. Table II shows the principal proposed diversions. The total may reach 300,000 acre-ft.

TABLE II—PROPOSED TRANSMOUNTAIN DIVERSIONS

Applicant	Diversion From	Diversion To	Elevation of Tunnel, Feet	Length of Conduit: Tunnel, Miles	Length of Conduit: Ditch, Miles	Estimated annual Diversion, Acre-Feet
City of Denver	Fraser River	Clear Creek	9,200	6½	31	100,000
do	Williams Fk.	do	10,400	3	19	36,000
do	Blue River	Tarryall Creek	10,300	3½	92	98,000
Water users in Arkansas Valley	Eagle River	Arkansas River	10,200	2	15	24,000
do	Fryingpan Cr.	do	11,600	2*	3	7,000
Water Supply & Storage Co.†	N. Fk. Colo. River	Cache la Poudre	.....	0	7	10,000
Total				17	167	275,000

* Ivanhoe tunnel on abandoned Colorado Midland Ry.
† Proposed extension of Grand River ditch.

The monthly amount of water possible of diversion under each plan has been computed for the year 1916, which was practically a normal year, as shown by the 22-year record of Colorado River at Glenwood Springs and the results are given in Table III.

TABLE III—TOTAL MONTHLY DIVERSIONS FOR NORMAL YEAR

Diversion	Total Amount Diverted in Acre-Feet: May*	June	July	Aug.	Sept.	Oct.
Fraser River	14,300	34,400	14,800	9,400	5,030	3,660
Williams Fork	1,980	14,500	8,500	4,670	2,240	1,760
Blue River	9,510	36,000	21,300	15,600	6,320	6,280
Eagle River	3,190	10,900	3,230	1,510	1,020	730
Fryingpan Creek	750	2,890	1,410	715	308	164
No. Fk. Colorado River	1,270	3,960	1,580	875	668	504
Total	31,000	103,000	79,900	32,800	15,600	13,100

* Partial month.

The effect of these diversions upon the discharge of the Colorado River at the state line is shown in Table IV by a comparison with the discharge of the Colorado River near Fruita (near the state line) for 1916.

The slight effect that the proposed diversions will have upon the flow of the Colorado River at the state line shows how groundless are any fears that [illegible] be entertained as to the effect of transmountain diversions upon the flow of the lower Colorado.

TABLE IV—EFFECT OF DIVERSIONS ON DISCHARGE OF COLORADO RIVER NEAR FRUITA

	Discharge in Acre-Feet: May	June	July	Aug.	Sept.	Oct.
Recorded discharge	1,410,000	1,910,000	769,000	536,000	240,000	167,000
Proposed diversion	31,000	103,000	79,900	32,800	15,600	13,100
Reduced discharge	1,380,000	1,810,000	689,000	503,000	224,000	154,000
Per cent of recorded flow	98	95	90	94	93	92

The topography of the upper Colorado basin is such that it is confidently believed the proposed plans represent closely the limit of transmountain diversions, at least for many years to come. In order to divert the 275,000 acre-ft. proposed, it will be necessary to build 17 miles of tunnel and 167 miles of ditch, an undertaking of great magnitude.

The accompanying diagram represents roughly the section through the range on the headwaters of Fraser River and is typical of similar sections on other headwater streams. This diagram shows that as the elevation of the proposed tunnels decreases their lengths increase greatly. Near the mouth of Fraser River (El. 8,500 ft.) a tunnel would be 14 miles long and would intercept the run-off from 220 sq.mi., amounting to 158,000 acre-ft. A system of collection ditches would increase this amount somewhat. On Williams Fork, if the proposed tunnel were lowered 900 ft. to El. 9,500 ft., its length would be increased from 3 to 7 miles and the run-off intercepted would be increased from 36,000 to 56,000 acre-ft. On Blue River a lowering of the proposed tunnel 800 ft. (El. 9,500 ft.) would increase its length from 3½ to 17 miles. It is impossible to state the amount of run-off that would be intercepted, because long collection ditches are needed in this basin, and the success of these is doubtful. On Eagle River a tunnel 700 ft. lower (El. 9,500 ft.) than that proposed would be 14 miles long and would intercept the run-off from 67 sq.mi., amounting to 50,000 acre-ft.

The foregoing facts show that the increased expense of the greater lengths of tunnels is out of proportion to the increased amount of water intercepted. This is due to the fact that the snowfall on the mountain range is heaviest at the top and decreases greatly with a decrease in altitude. (Follansbee, Robert, "Some Characteristics of Run-Off in the Rocky Mountains," Water Supply Paper 500-C, U. S. Geological Survey.) Investigation of the stream-flow records on Fraser River shows that at El. 9,200 ft. the annual run-off is 1,200 acre-ft. per square mile. The unit run-off from the area between that and the mouth of the river (El. 8,000 ft.) is only 644 acre-ft. per square mile or about half of that from the upper area. Exact figures can not be given for the other headwater streams but data on other mountain streams all confirm the statement that unit run-off in a drainage basin decreases rapidly with decrease in altitude.

Any proposals to divert greater amounts than those already outlined will face the adverse conditions of greatly increased cost of tunnels which will cover areas yielding a decreasing amount of additional water. These two adverse conditions of greatly increased cost and decreasing unit run-off from the additional areas reached illustrate admirably the economic law of "diminishing returns," and it is confidently believed that this law will operate against any considerable extension of diversions beyond those proposed.

Engineering Literature

A MONTHLY REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

A New Book by Secretary Hoover

AMERICAN INDIVIDUALISM—By Herbert Hoover. Garden City, N. Y.: Doubleday, Page & Co. Cloth; 5x7 in.; pp. 72. $1.

This little book, which can be read in less than an hour, reveals another of the many sides of Herbert Hoover, that of social philosopher. The thesis of the book is that the social philosophy of our institutions is that of individualism, but individualism restrained by insistence upon maintaining equality of opportunity for all. The ideals of this individualistic philosophy are thus expressed by Mr. Hoover:

> That while we build our society upon the attainment of the individual, we shall safeguard to every individual an equality of opportunity to take that position in the community to which his intelligence, character, ability, and ambition entitle him; that we keep the social solution free from frozen strata of classes; that we shall stimulate effort of each individual to achievement; that through an enlarging sense of responsibility and understanding we shall assist him to this attainment; while he in turn must stand up to the emery wheel of competition.

These ideals Mr. Hoover proceeds to examine on philosophic, spiritual, economic and political grounds. The argument is particularly interesting when it relates to the economic and political phases. Mr. Hoover reviews the various curbs to individualism that have been developed as a result of our industrial progress and points out how legal inhibition has steadily tended to thwart the adverse influence of these developments. He says:

> The growth of corporate organizations, of our banking systems, of our railroads, of our electric power, of our farm co-operatives, of our trade unions, of our trade associations and of a hundred others, indeed, develops both beneficent and malign forces. The timid become frightened. But our basic social ideas march through the new things in the end. * * * Progress requires only a guardianship of the vital principles of our individualism with its safeguard of true equality of opportunity in them. * * * A great test of the soundness of a social system must be its ability to evolve out of itself those orderly shifts in its administration that enable it to apply the new tools of social, economic and intellectual progress, and to eliminate the malign forces that may grow in the application of these tools.

In his discussion of the political phases of our individualistic philosophy, Mr. Hoover lays down very precisely the dividing line between government regulation of the forces of business and government production or distribution of commodities and services. The government's duty is to safeguard equality of opportunity, which is accomplished by regulation; it must maintain the initiative of our people, which is accomplished by the government staying out of production and distribution.

Very neatly does Mr. Hoover dispose of the demagogues who find fault with our system and who live by pointing out its deficiencies. He admits that our social system, as well as any other, contains faults, but these faults are to him but the spur for renewed energy in their removal—energy which is but a demonstration of the vitality of our social ideals.

The book closes with a chapter on the future in which Mr. Hoover reiterates his faith in our social ideals—a chapter which might well become recurrent reading for all who think. Particularly, would it be good reading for those to whom this incisive sentence applies, "The perpetual howl of radicalism is that it is the sole voice of liberalism—that devotion to social progress is its field alone."

The book deserves wide circulation and serious study. It has been placed on our shelves alongside the contributions to social thinking of two other great engineers, alongside of Morrison's "New Epoch," the crystallization of thinking on the "manufacture of power," and Steinmetz's "America and the New Epoch," a most stimulating book, although it contains much with which to disagree.

The Technique of Freight Transportation

RAILROAD FREIGHT TRANSPORTATION—By L. F. Loree, President Delaware & Hudson Co., Chairman Kansas City Southern Railway Co. New York: D. Appleton & Co. Cloth; 5¼x8¼ in.; pp. 771; halftones and line cuts. $5.

There is no lack of books on the various phases of railroad engineering and operation. Location, design, construction, administration, accounting, all have been discussed at length from the viewpoint of the specialist. It has remained for Mr. Loree, however, to present an exhaustive and authoritative exposition of the technique of railroad transportation, with respect to its major economic function of moving the produce of our mines, fields, and factories. Although, in carrying out this purpose, he has been compelled to treat of the several technical services involved in the maintenance and operation of the transportation machine, he has limited this treatment to those considerations which have a direct bearing upon freight transportation.

Mr. Loree handles his subject under seven main heads. The first of these deals especially with the work of the civil engineer and discusses the permanent way as an essential factor in the conduct of transportation. Track, structures, grade and alignment improvements, water and coal stations, signals, yards, and all other elements that go to make up the fixed railroad structure are discussed at length with respect to their contribution to adequate and economical transportation.

Then follow sections on shops and equipment, field and staff organization, accounts and statistics, the movement of cars, the movement of engines and trains, and finally a very full section, divided into two parts, in which is reviewed the history of railroad labor relations and the current problems involved in the human side of the industry.

All of these chapters may be read with profit by the engineer in whatever field he may be working. At times he may find irksome the detailed description of operations unrelated to his own work, but on the whole the book is easy reading and affords an exceptional outlook upon the technical problems of our second national industry, in the operation of which engineering is so vital an element.

Aside from the identity of the author as president of one railroad and chairman of another, and from his lifetime of experience as a railroad engineer and executive, the best index to the practical and authoritative character of the book is found in the following quotation from the foreword, in which Mr. Loree describes the process of its making:

> I therefore sat down to the preparation of a series of memoranda on freight transportation, pointing out some of the things that help and some that hinder the prompt and regular movement, and this in spite of a full recognition that there is a universality of duty and interest running through the whole railroad world which makes it very difficult to deal with one part of that world only. These were submitted, from month to month, to the officers of the companies of which I had charge, for discussion and consideration with reference to their own situation and practice. The methodical study of problems thus presented serves to focus thought and activity upon current duties with the happiest results. Prepared originally for the officers of my own companies, I venture to offer this material, expanded and rearranged, to the whole body of railroad officers in the hope that it may be helpful to them.

Least Squares

REVIEWED BY OSCAR S. ADAMS

Mathematician, U. S. Coast Goedetic Survey, Washington, D. C.

PRACTICAL LEAST SQUARES—By Ora Minor Leland. New York and London: McGraw-Hill Book Co. Cloth; 6 x 9 in.; pp. 237. $3.

This work is based upon a series of lectures that the author gave for several years to classes of civil engineering students at Cornell University. As the title indicates, it is the practical side of the subject that is kept in the foreground throughout. To the man who wants to use "Least Squares" as a tool in his work, this feature cannot be commended too highly. The pure mathematician may prefer the theoretical side of the subject, but the engineer and the physicist want to know how to apply the method to the problems in hand.

The introduction gives a clear discussion of the various classes of errors, and passes from the assumption of the arithmetic mean to the method of least squares. All people who deal with the measurement of physical quantities have need to note carefully this classification of the errors that may enter into observations, as well as to master the most practical method of dealing with accidental errors. This introduction is therefore important and the subject is well treated in a style that is easily followed.

After a short chapter on "direct observations of one quantity" we pass to "indirect observations of a function of the unknown quantities." Incidentally the subject of weighting of observations is developed and illustrated by examples.

The formation and solution of normal equations are important features that must be thoroughly mastered by those who wish to apply the method to practical problems. A very well written chapter is therefore devoted to the subject of the solution of such sets of equations.

The two chapters treating of "observations of dependent quantities; conditioned observations" are devoted largely to the adjustment of triangulation. This is a phase of the subject in which the author has had a great deal of experience and hence he is well qualified to present the matter in a clear and concise manner. There is no other field that illustrates in such a striking manner the practical utility of the method of least squares for reconciling the various discordant results due to the accidental errors of observation. Such complicated inter-relations arise due to the geometric equations of conditions that such a tool is absolutely necessary for the practical elimination of the discrepancies.

Engineers may well profit by these two chapters written in a readable style by an acknowledged authority on the subject. To other readers, this phase of the applications should be of interest because it furnishes such an excellent field for illustrating the general principles of the method of adjustment of observations.

To the physicists, the chapter "empircal formulas" will be more directly of interest and use. After the type of the curve is decided upon the method of least squares gives the most satisfactory scheme for determining the necessary constants.

The subject of precision is taken up toward the end of the book since for practical applications this part is less important that the method of using "least squares" for adjustment purposes. This phase of the subject is more theoretical and hence not much more is given than the required formulas. In the four appendices, some account is given of the theory upon which the subject is founded; this part will of course be of least interest to the practical man.

The whole work is written in the lecture style and is well illustrated by examples that are solved in the text. The subject matter might possibly have been better arranged for reference work, but the rather full index will serve as an aid in locating any desired topic. As a text-book, it has the disadvantage of being devoid of problems to be solved by the student. No greater help can be found for mastering a mathematical subject than the solution by the student of problems illustrating the principles that have been established. As a practical text for the non-mathematical worker it must be given a high place and it deserves careful consideration by the pure mathematician as well.

Short Essays on Industrial Economics

SOME PROBLEMS IN CURRENT ECONOMICS—By M. C. Rorty, M.E., E.E., President National Bureau of Economic Research, Assistant Vice-President American Telephone and Telegraph Co. New York: A. W. Shaw Co. Cloth; 5 x 8 in.; pp. 142. $1.25.

In five brief esays Mr. Rorty has presented a series of studies on the economic, financial, and statistical aspects of modern industry. He makes no claim to thoroughness from the standpoint of the trained economist and has sought to base the various discussions upon fact rather than upon opinion or personal judgment. The author has provided a check upon his dicta concerning controversial subjects by submitting his text to friends, representative of the Socialist and labor viewpoints. Their comments and criticisms have been printed as footnotes to the text with which they take issue, a procedure that is exceedingly helpful to the reader in contrasting the diverse opinions.

The essays deal with industrial history, social and industrial organization, production and distribution, some pertinent statistics, in which the author discusses the relations between physical production, wages, and the distribution of the national income, and finally an outline of present day conditions ending with a constructive program for industrial development.

The author's viewpoint may best be understood from the following quotation from his preface:

After nearly twenty years' experience as engineer and executive, the necessities of the writer's employment compelled him, as a very practical matter, to undertake a study of economic fact and theory. In nearly every case the initial study of theory was incidental to the pressing demands of some practical problem. * * * This peculiar background for the several essays while explaining certain omissions may also, it is hoped, give the volume some degree of special usefulness to the practical man who feels the need for a general knowledge of economics, but lacks the time necessary for the reading of more technical and extensive treatises.

A Practical Book on Mosquito Control

MOSQUITO ERADICATION—By W. E. Hardenburg, Sanitary Engineer, Certified Member American Association of Engineers. New York and London: McGraw-Hill Book Co. Cloth; 6 x 9 in.; pp. 248; 146 half tones and line drawings. $3.

In writing this book the author's aim was to outline concisely the best practice in mosquito control, avoiding a bulky volume but omitting nothing of value. Thomas J. Headlee, entomologist, New Jersey Experiment Station, who has examined the volume for *Engineering News-Record*, gives his opinion of the volume as follows:

The book appears to be a pretty good digest of the principal facts relating to mosquito control as practiced in the United States, and should prove a useful handbook for persons engaged in the practical work itself, especially where that work is concerned with malarial mosquito control problems. The weakest part of the work is its consideration of the salt marsh mosquito control problems. That portion of the book devoted to educational and publicity matters is perhaps its best executed section. Of course, there are minor mistakes such as one finds in all books, but there do not appear to be enough of them to merit serious condemnation.

The opening chapter, The Toll of the Mosquito, deals with the insect as a vehicle for the transmission of malaria, yellow fever, dengue and filariasis. The economic significance of the insect both as a disease spreader and as an annoyance is discussed, particular attention being given to malaria as a labor problem. The entomology of the mosquito is taken up in a chapter entitled Some Disease Bearing American Mosquitos. Control measures are next considered, first by means of a review of a number of specific campaigns—in the Canal Zone, on the St. Louis & Southwestern R.R., and at and near American camps during the recent war. Chapters follow on initiating anti-mosquito campaigns and on administering the work when under way. These lead up to the engineering and allied aspects of the subject—inland and salt marsh drainage (40 and 20 pages, respectively), oiling, fish control, screening and various other measures, combative and protective, the latter including mass treatment by quinine of malaria-infected populations. The final chapter, Rural Mosquito and Malaria Control, takes up the need of a survey, the protection of homes in swamps, rice-field problems and rural community measures. Appendixes contain a table to assist in identifying certain common American mosquitos, an approved anti-mosquito ordinance, a leaflet for educational campaigns, and a bibliography.

Of the numerous earlier volumes on the mosquito control problem noticed in these columns the only one we remember as having been written from the engineering viewpoint is "Mosquito Control in Panama," by Joseph A. Le Prince and Dr. A. J. Orenstein (see *Engineering News*, Oct. 19, 1916). As its title indicates, that volume was restricted in scope. Mr. Hardenburg's book is comprehensive but concise and promises to be of much usefulness to the growing number of engineers and others concerned in mosquito control.

Bishop's Structural Drafting Revised

REVIEWED BY R. FLEMING
American Bridge Co., New York City

STRUCTURAL DRAFTING AND THE DESIGN OF DETAILS—By Carlton Thomas Bishop, C. E., Assistant Professor of Structural Engineering, Sheffield Scientific School of Yale University; formerly Draftsman for the American Bridge Company and Chief Draftsman for the Hay Foundry & Iron Works. Second Edition Revised. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 11 x 9 in.; pp. 352; illustrated. $5. (25s. net.)

In reviewing the first edition of this book (*Engineering News-Record*, June 17, 1920, p. 1215) the present writer made the prediction that the general excellence of its contents would make it a standard in the field of structural drafting for some time to come. That this has been the case is verified by the favorable reception and large sales accorded to the book.

The revisions in the second edition consist mainly in changing the weights, dimensions and properties of I-beams and channels to conform to the revised standards adopted in 1920, of the Association of American Steel Manufacturers; also the weights, dimensions and properties of Bethlehem I-beams and girder beams to conform to the standards of the Bethlehem Steel Co., effective Oct. 1, 1922. The diagram and the formula used in determining the net sections of tension members have been modified to facilitate finding the rivet-hole areas to be deducted. The paragraphs on Shear (p. 202) and on Members which Resist Bending and Direct Stress (p. 215) have been partially rewritten for greater clearness. It is noted that some statements (pp. 121, 219, 266) which the reviewer criticized have been corrected.

Revisions could well have been made in a few figures embodying details that are becoming obsolete. The author and the reviewer evidently still differ regarding notation expressing moments: "pound-feet" or "foot-pounds," "pound-inches" or "inch-pounds." The reviewer still thinks that a few short additions could profitably be made: rolled steel slabs, angle clips at ends of members, drafting-room errors could each have two or three paragraphs.

The book as it stands is a credit to both author and publisher and will doubtless long continue to be the leading authority on the subject of which it treats.

For Large Industrial Concerns

STORES AND MATERIALS CONTROL: Including Procurement by Manufacture and by Purchase—By Madison Cartmell, A.B., Consulting Industrial Engineer, Assoc. M. A.S.M.E., Member National Association of Cost Accountants. New York: Ronald Press Co. Cloth; 6 x 9 in.; pp. 459; line cuts. $4.50 net.

Construction companies, except the very largest, will get little but general principles from this volume which offers, however, a most comprehensive manual of directions and working forms for manufacturers and large industrial concerns having a continuous heavy stock of materials to procure and store. The book gives about equal space to procurement and to control, there being 217 pages on control including storing and 40 pages on procurement by manufacture and 120 pages on procurement by purchase.

Essentially the book is a manual. It explains in detail proceedings, records and accounting. Forms are suggested for records and accounts of all kinds, and there are control charts of various sorts. From all these the large construction organization can draw suggestions, but they are prepared specifically for the manufacturer.

The Study of Labor Problems

AN INTRODUCTION TO THE STUDY OF LABOR PROBLEMS —By Gordon S. Watkins, Ph.D., Associate Professor of Economics, University of Illinois. (Crowell's Society Service Series.) New York: Thomas Y. Crowell Co. Cloth; 6 x 9 in.; pp. 664. $3 net; postage extra.

Here is an effort to present in one fair-sized volume a review of the basic facts and a survey of the current trends that have to do with the human side of industrial relations. Prof. Watkins has divided his work into three parts. The first describes the nature and relates to the growth of labor problems from the earliest of social relations through the complications that arose with the industrial age in Europe to their later development in the United States. This part is brief and necessarily sketchy, but it is helpful because of its very simplicity.

The second part analyzes the problem. Here are discussed the various factors that enter into it, such as the standard of living, wages, hours of labor, women and children in industry, human waste, unemployment, labor turnover, immigration and industrial unrest. In his analysis Prof. Watkins is in general fair and constructive, although in spots he sets forth ideals and aspirations as though they had already become realities and might be attained or realized by fiat or enactment.

In Part III are considered the agencies and methods of readjustment. It touches upon organizations both of labor and of employers, the adjustment of industrial disputes through legislation and through the internal organization of industry, personnel administration, industrial education and training, co-operative movements, socialism, labor legislation and social insurance. Although Prof. Watkins disclaims reliance upon any panacea for healing economic strife, it is evident that he has high hopes of what he calls "a greater degree of democratic control." To what extent he would be willing to place the control of industrial property and resources in the hands of irresponsible and oft-times transient employees he does not make clear. It is evident, however, that as regards the controversial aspects of the labor problem, the author is disposed to smile encouragement to the employee and to frown admonition upon the employer. This is best illustrated perhaps by contrasting his conclusions as to labor unionism with those concerning employers' associations:

Unionism is a product of industrial conditions, and is therefore inevitable and necessary. If the lessons of history teach anything, it is that labor organizations cannot be crushed and that if suppression were possible it would not be desirable either industrially or socially. Unionism is indispensable to the protection of the workers' interests against the selfish and unsocial attitude and practices of unscrupulous employers. Labor organizations, however, when allowed to function uncontrolled by society may be a power for harm. It becomes necessary, therefore, for society to legalize the peaceful functions of unionism and to punish violent and illegal activity. Such punishment, however, must be based upon adequate and impartial investigation of fact and not upon the perjured evidence and testimony of anti-union forces.

* * * * * *

To gain public approval and confidence, associations of employers must adopt a three-fold policy: (1) Every effort must be made to prevent monopolistic control of prices, whether secured by the associated employers independently or acting in collusion with labor organizations. (2) Their activities with regard to industrial relations must be constructive rather than destructive, that is, they must recognize the necessity and justification of organization and collective bargaining on the part of the workers and accord to the latter the same rights and privileges which they claim for themselves. (3) They must recognize that industry, business and commerce should be administered for public service and not for the aggrandizement of private interest; that production is a partnership, in the management of which consumers and employees should have a voice. Functioning to these ends employers' associations will become an institution fundamental to the maintenance of industrial peace and the promotion of social progress.

Prof. Watkins' book is not essentially controversial, and the display of personal sympathies in no wise detracts from its worth as a compact and comprehensive summary of the field of industrial relations. As a work for convenient reference it will fill a place of unquestioned importance.

Modern American Locomotives

LOCOMOTIVE CYCLOPEDIA OF AMERICAN PRACTICE: Definitions and Typical Illustrations of Locomotives, Their Parts and Equipment; Descriptions and Illustrations of the Tools and Methods Employed in Their Construction and Repair; Locomotives Built in America for Industrial Operations and for Foreign Railroads—Sixth Edition, 1922. Compiled and Edited for the American Railway Master Mechanics Association, Division V, Mechanical (Formerly American Railway Master Mechanics Association). Editor, Roy V. Wright, Managing Editor of the *Railway Age* and Editor of the *Railway Mechanical Engineer*; Managing Editor, Charles N. Winter, Managing Editor of the *Car Builders' Cyclopedia* and Associate Editor of the *Railway Age*. Advisory Committee: A. W. Gibbs, Chief Mechanical Engineer, Pennsylvania Railroad; F. J. Carty, Mechanical Engineer, Boston & Albany; G. S. Goodwin, Mechanical Engineer, Chicago, Rock Island & Pacific; F. H. Hardin, Chief Engineer Motive Power and Rolling Stock, New York Central Lines. New York: Simmons-Boardman Publishing Co. Cloth; 9 x 12 in.; pp. 1,155; 2,740 illustrations. Cloth $8. Leather $12.

As a detailed and comprehensive book on the modern locomotive and its innumerable parts and appliances, this book has great value and interest, but it must be explained that it does not deal with locomotive design or history. A good share of the credit for initiating and preparing an encyclopedia of the locomotive must be given to the American Railway Master Mechanics Association (now merged with the American Railway Association), for in 1905 it authorized the *Railway Gazette* to publish an "illustrated dictionary," under the supervision of a committee of the Association. Each of the six editions has been prepared with the assistance of an advisory committee composed of railway mechanical officers. Much individual information is given by builders of locomotives and manufacturers of appliances.

In this edition a new system of classification of subjects has been introduced. A 90-page dictionary of terms is followed by about 100 pages of general descriptions of steam locomotives of various classes. Then come descriptions and drawings of practically every part and appliance used in the construction and equipment of a locomotive and its tender. This portion includes special chapters on such subjects as locomotive tests and inspection, feed water treatment, brakes, heating apparatus and electric headlights. There are also numerous specifications, as for forgings, axles, wheels, tires, springs and iron and steel castings. Drawings of train-control apparatus are given, although there is no descriptive text relative to train-control systems.

Electrification (about 56 pages) includes descriptions of different types of locomotives and control systems, electrical appliances, and several main-line electric installations. A section on foreign and industrial locomotives takes up only American engines exported to numerous countries. Industrial locomotives include fireless, compressed air, geared, rack and electric

engines. Materials of construction (with specifications), safety appliances and tool equipment for locomotives are subjects of separate chapters. A section on shop work is of special interest since it includes methods of scheduling and routing the repair work of a locomotive as well as a study of machine-tool performance and detailed descriptions of a variety of machine tools used in railway shops.

Profuse illustration is a feature of the book and both its halftones and line engravings are excellent, with clear and legible lettering on the drawings. The quality of the paper is a great aid to this result. Many of the halftone views are accompanied only by brief lists of general dimensions, but they are of interest in showing varied designs of engines of the same type as well as engines of numerous different types. Accessories include an index, table of contents, index of trade names and directory of manufacturers of materials and appliances.

Testing Paints, Varnishes and Colors

REVIEWED BY ROBERT JOB

Vice-President Milton Hersey Co., Ltd., Montreal; Chemist, Lehigh Valley Railroad; Chemist, Grand Trunk Railroad and Canadian National Railways; Assistant Chemist, Canadian Pacific Railway

PHYSICAL AND CHEMICAL EXAMINATION OF PAINTS, VARNISHES AND COLORS.—By Henry A. Gardner, Director Scientific Section, Educational Bureau, Paint Manufacturers' Association of the United States; National Varnish Manufacturers' Association, Co-operating. Washington, D. C.: P. H. Butler, Sales Agent, 1845 B St., N. W. Cloth; 6 x 9 in.; pp. 219; various circulars of the U. S. Bureau of Standards; halftones and line cuts. $9.

During recent years much experimental work has been done on the chemical and more particularly the physical testing of paints, varnishes, japan driers and various paint oils and thinners. The American Society for Testing Materials has taken an active part in this work through its Committee D1., and the same has been true of the United States Government through various branches, particularly the Bureau of Standards. Also the Paint Manufacturers' Association of the United States through its Scientific Section has been doing excellent work. Mr. Gardner, who has been closely identified with these investigations, has here collected some of the more important of these data, with the object of placing conveniently in the hands of paint manufacturers and testing engineers methods of analysis and of physical test for the various paint materials, and he has also collected in the latter part of the book the recent specifications of the United States Federal Specifications Board pertaining to these materials.

Taken as a whole, Mr. Gardner's work will be a most useful addition to the reference library of the manufacturer and paint technologist, as well as to the laboratory work-bench. The methods have been carefully developed, and various useful forms of apparatus are described which have been designed by Mr. Gardner and his associates, and this work will unquestionably assist in further progress.

Some omissions may be noted: The physical testing of japan driers is more important as a means of practical valuation than the chemical analysis; also wood turpentine of various grades is widely used. Some grades are of very good quality and satisfactory for general shop use. Other grades, however, are so objectionable that they cannot be used without causing discomfort and difficulty. The chemical analysis is often within the usually accepted limits, but some standard as to odor might well be adopted.

The standard specifications of the Federal Specifications Board are of great value. Occasionally they are rather complex, and as a result of further work they can no doubt be simplified. For example, the specifications for Water-Resisting Spar Varnish seem cumbersome, and as a matter of practice the reviewer finds that they cannot be depended upon to ensure getting varnish which when applied to railway cars exposed to great variations of temperature will give the eighteen months' service which should be readily secured from high-grade varnish of proper quality. This, however, merely means that further development is needed, and Mr. Gardner rightly points out the vital importance of the physical testing of varnishes as contrasted with mere chemical analysis.

Mr. Gardner's work should be in the hands of everyone interested in manufacturing or testing paint materials.

German Tests of Various Woods

REVIEWED BY HERMANN VON SCHRENK

Consulting Timber Engineer, St. Louis, Mo.

DIE BISHERIGEN ERGEBNISSE DER HOLZPRÜFUNGEN IN DER MATERIALPRÜFUNGSANTALT AN DER TECHNISCHEN HOCHSCHULE STUTTGART.—Von R. Baumann. Berlin: Julius Springer (for the Vereins deutscher Ingenieure). Paper; 8 x 11 in.; pp. 139; 87 diagrams and 13 double-page plates devoted largely to the microscopic structure of woods.

This paper deals largely with the results obtained during the war period in making tests for the development of wood parts for airplane and motor-truck service. Various samples submitted commercially were tested in an all-dry condition. The samples included the usual coniferous woods available in Germany, such as pine, spruce, and larch; North American Douglas fir, hemlock, white pine; South American Kauri pine; and among hardwoods, all the European varieties and numerous foreign woods, such as teak, gahoon, mahogany and jarrah.

After an introduction giving detailed descriptions of the methods of testing, which included compression, torsion, hardness and glue tests, the author describes the various strength properties of the woods in detail, discussing among other factors the influence of direction of cutting, comparative value of heart and sapwood, moisture, influence of knots, direction of grain, influence of defects, of moisture, of frost, of age, and of treatment with oils and other preservatives. Detailed descriptions of the species considered are given.

For American engineers the paper is of interest largely because of the methods employed in making the investigations, although there are tables dealing with strength factors of American woods. There are in addition certain definite remarks which confirm many American investigations. Mr. Bauman finds that under equal conditions sapwood is as strong as heartwood. He also confirms the findings of the U. S. Forest Service that density is a vital factor in determining the strength of coniferous woods, calling particular attention to the relation of the harder summer wood in the following words: "In considering the strength, therefore, it is essential in similar pieces to consider not the width but the relation between the hard and soft portions of the annual ring."

The only defect of an otherwise excellent paper is a lack of conclusions in various chapters.

PUBLICATIONS RECEIVED

New Books and Revised Editions

AMERICAN RAILROADS: Government Control and Reconstruction Policies—By William J. Cunningham, A.M., James J. Hill Professor of Transportation, Graduate School of Business Administration, Harvard University. New York, Chicago and London: A. W. Shaw Co. Cloth; 6 x 8 in.; pp. 409. $3.

COST ACCOUNTING PROCEDURE—By William B. Castenholz, A.B., C.P.A., Director Department of Higher Accountancy, La Salle Extension University. Chicago: La Salle Extension University. Cloth; 6 x 9 in.; pp. 333; illustrated. $3.50.
Underlying principles and their application discussed and accounting methods presented; based chiefly on production orders.

THE LAW OF CITY PLANNING AND ZONING—By Frank Backus Williams, A.M., LL.B., of the New York Bar. [The Citizen's Library of Economics, Politics and Sociology. New Series]. New York: The Macmillan Co. Cloth; 6 x 9 in.; pp. 738. $5.

MECHANICAL WORLD YEAR BOOK, 1923. Manchester, England: Emmott & Co., Limited. Cloth; 4 x 6 in.; pp. 348. 1s.

THE PLANNING OF THE MODERN CITY: A Review of the Principles Governing City Planning—By Nelson P. Lewis, M. Am. Soc. C. E., M. Am. City Planning Inst., formerly Chief Engineer of the Board of Estimate and Apportionment of New York City. With the Assistance of Harold M. Lewis, M. Am. Soc. C. E. Second Edition Revised. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 6 x 9 in.; pp. 457; 87 plates and 62 figures and diagrams in the text. $5.

PRACTICAL MECHANICS AND STRENGTH OF MATERIALS—By Charles Wilbur Leigh, B.S., Associate Professor of Mechanics at the Armour Institute of Technology. New York and London: McGraw-Hill Book Co. Cloth; 5 x 8 in.; pp. 293; illustrated. $2.25.
Designed for night and vocational schools, short college courses in mechanics and men engaged in practical construction work; in each chapter on Strength of Materials there is first given the "principles of mechanics that are necessary." A working knowledge of algebra, geometry and trigonometry is considered sufficient for those using the book.

PRATIQUE DU CALCUL DU BÉTON ARMÉ—Par G. Magnel, Chargé de Béton Armé a L'Université de Gand, Chef des Travaux au Labatoire de Résitance des Matériaux. I Partie. Gand, France: Van Rysselberghe & Rombaut. Paper; 6 x 9 in.; pp. 159; line cuts.

RAPID ARITHMETIC: Quick and Special Methods in Arithmetical Calculation Together with a Collection of Puzzles and Curiosities of Numbers. By T. O'Connor Sloane, Ph.D., LL.D., Author of Arithmetic of Electricity, Standard Electrical Dictionary, etc. New York: D. Van Nostrand Co. Cloth; 6 x 9 in.; pp. 189. $1.50.

STANDARD SPECIFICATIONS FOR STEEL HIGHWAY BRIDGES—Ottawa, Ont.: Canadian Engineering Standards Association, West Block. Stiff Paper; 6 x 9 in.; pp. 75; line cuts. 25c.

A TREATISE ON THE LAW OF SURVEYING AND BOUNDARIES—By Frank Emerson Clark of the Minnesota Bar. Indianapolis, Ind.: The Bobbs-Merrill Co. Cloth; 6 x 9 in.; pp. 631; illustrated. $5.

THE WORLD ALMANAC AND BOOK OF FACTS, 1923—Edited by Robert Hunt Lyman. New York: Press Publishing Co. Paper; 6 x 9 in.; pp. 888. 35c.; 50c. postpaid.
New matter added to the wide range of facts previously included increases the value of this highly useful annual, which continues to be offered at a nominal price.

Reports and Pamphlets in Various Fields

AMERICAN SOCIETY FOR TESTING MATERIALS: Proceedings, 1922. Philadelphia: As above, 1315 Spruce St. Two volumes. Cloth; 6 x 9 in.; pp. 1,023 and (technical papers) 591; illustrated. $6 per volume.

CANADIAN RAILWAY STATISTICS, 1921. Ottawa, Ont.: Dominion Bureau of Statistics. Paper; 6 x 9 in.; pp. 236.

CAUSTIC MAGNESIA CEMENT. Washington, D. C.: Bureau of Standards. Paper; 7 x 10 in.; pp. 14. 5c. from Superintendent of Documents, Washington, D. C.

CITY MAPPING: The Making of Topographical Maps of Cities and Towns, the First Essential in Town Planning—By Douglas H. Nelles, Ottawa, Ont.: Geodetic Survey of Canada. Paper; 6 x 9 in.; pp. 40.

DAILY RIVER STAGES at River Gage Stations on the Principal Rivers of the United States, 1921—By H. C. Frankenfield, Meteorologist. Washington, D. C.: U. S. Weather Bureau. Paper; 9 x 12 in.; pp. 277.

EFFECT OF NICKEL-CHROMIUM ON CAST-IRON—By Richard Moldenke, E.M., Ph.D., Watchung, N. J. Reprinted from *Transactions* Am. Inst. Min. and Met. Engrs. Bethlehem, Pa.: Bethlehem Steel Co. Paper; 6 x 9 in.; pp. 23.
An extended series of cast-iron test bars was poured from crucible-melted iron. The findings indicate that standard bars having medium total carbon, low phosphorus, silicon about 1.75 per cent, and nickel and chromium 0.15 each, will bear a transverse load some 600 lb. greater than one without the alloying elements.

FEDERAL POWER COMMISSION: Report for 1921-22. Washington, D. C.: Paper; 6 x 9 in.; pp. 316.
Summarizes work of year; includes federal water-power act and amendments, orders and decisions of commission, applications for permits and terms of permits issued.

HYDRO-ELECTRIC DEPARTMENT OF TASMANIA: Report for 1921-22. J. H. Butters, Chief Engineer and General Manager, Hobart, Tasmania. Paper; 8 x 13 in.; pp. 54; illustrated.

INDUSTRIAL DEVELOPMENT OF KANSAS—By P. F. Walker, M.M.E., Professor of Industrial Engineering and Dean of the School of Engineering, University of Kansas. Part I: Text. paper; 6 x 9 in.; pp. 53; folding plates. Part II: Industrial Map Section; paper with cloth back; 12 x 12 in. Lawrence, Kan.: Engineering Experiment Station.
A survey of industrial opportunities.

INTERIOR BUILDING CONSTRUCTION: Report on Metal Lath and Gypsum Plaster on Wood Support, Jointly Submitted by Associated Metal Lath Manufacturers, Chicago, Ill., and National Lumber Manufacturers' Association, Chicago and Washington, D. C. Chicago: Underwriters Laboratories, National Board of Fire Underwriters. Paper; 6 x 9 in.; pp. 129; illustrated.
Reports on various tests of above-mentioned fire retardant, with classification recommendations.

INTERSTATE COMMERCE COMMISSION: Report for 1921-22. Washington, D. C. Cloth; 6 x 9 in.; pp. 239.

A LIST OF ALLOYS—By William Campbell, Professor of Metallurgy, School of Mines, Columbia University. Reprinted from *Proceedings* American Society for Testing Materials. Philadelphia: C. L. Warwick, Secretary, 1315 Spruce St. Paper; 6 x 9 in.; pp. 32. $1; 85c. for five or more copies.
A list of some 1,500 different alloys, giving name and chemical composition, grouped in seventeen different classes, from brasses to fusible metals, heat resisting alloys and non-corrosive metals. The list is more complete than any previously published.

MAGNETIC DECLINATION IN THE UNITED STATES FOR JAN. 1, 1920—By Daniel L. Hazard, Assistant Chief, Division of Terrestial Magnetism. Washington, D. C.: U. S. Coast and Geodetic Survey. Paper; 6 x 9 in.; pp. 30; folding maps. Free on application.
An isogonic chart for 1920, containing not only the isogonic lines (lines of equal magnetic declination) but also the lines of equal annual change of declination, is supplemented by a brief summary of the phenomena of magnetic declination, and by brief but thorough instructions for making azimuth observations on Polaris or on the sun. Tables are given for use in the calculations for azimuth.

NATIONAL CONFERENCE ON CITY PLANNING: Proceedings, 1922. Flavell Shurtleff, Secretary, 130 E. 22nd St., New York City. Cloth; 6 x 9 in.; pp. 214; pp. 225.
Among other papers are: "The Design of the Street System in Relation to Vehicular Traffic," by E. P. Goodrich, consulting engineer, New York City, and "The Fundamentals of Transit Planning for Cities," by Daniel L. Turner, consulting engineer, New York City.

NEW YORK STATE BRIDGE AND TUNNEL COMMISSION. Report for 1921. Albany, N. Y. Paper; 6 x 9 in.; pp. 80; illustrated.

SOUTHERN APPALACHIAN WATER POWER CONFERENCE—Proceedings of First Annual Meeting, Asheville, N. C., June 20-22, 1922. Knoxville, Tenn.: J. A. Switzer, Secretary. Paper; 6 x 9 in.; pp. 143.

STATISTICS OF RAILWAYS IN THE UNITED STATES, 1920. Washington, D. C.: Interstate Commerce Commission. Cloth; 9 x 12 in.; pp. 471.

A STUDY OF COAL MINE HAULAGE IN ILLINOIS—By H. H. Stock, Professor of Mining Engineering; J. R. Fleming, Research Associate in Mining Engineering; A. J. Hoskin, Research Assistant Professor of Mining Engineering. Urbana, Ill.: Engineering Experiment Station. Paper; 6 x 9 in.; pp. 136; line cuts, halftones.

SURFACE WATER SUPPLY OF CANADA: Arctic and Western Hudson Bay Drainage (and Mississippi Drainage in Canada) in Alberta, Saskatchewan, Manitoba and Western Canada, Climatic Year 1919-20—By C. H. Atwood, A.M.E.I.C., District Chief Engineer, Winnipeg, Manitoba, and Arthur L. Ford, District Chief Engineer, Calgary, Alberta. Ottawa, Ont.: Dominion Water Power Branch. Paper; 6 x 9 in.; pp. 343; folding map.

SYSTEM OF ACCOUNTS: Prescribed for Licensees under the Federal Water Power Act—First issue approved Nov. 20, 1922. Washington, D. C.: Federal Power Commission. Paper; 6 x 9 in.; pp. 39.

THE TECHNOLOGY OF SLATE—By Oliver Bowles. Washington, D. C.: Bureau of Mines. Paper; 6 x 9 in.; pp. 132; illustrated. One copy free; 20c. from Superintendent of Documents.
On slate quarrying and waste utilization.

TESTS OF DRAINAGE PUMPING PLANTS IN THE SOUTHERN STATES—By W. B. Gregory, Irrigation Engineer. Washington, D. C.: Bureau of Public Roads. Paper; 6 x 9 in.; pp. 54; halftones and line cuts.
Reviews types of pumps in use in section named; discusses suction and discharge pipes and sources of power and operating costs; gives test results.

UNITED STATES GEODETIC SURVEY: Report for 1921-22. Washington, D. C. Cloth; 6 x 9 in.; pp. 148; illustrated.

UNITED STATES SHIPPING BOARD: Report for 1922. Washington, D. C. Paper; 6 x 9 in.; pp. 306.

THE VISCOSITY OF RAW MATERIAL SLURRY USED IN THE MANUFACTURE OF PORTLAND CEMENT—Compiled by J. W. Christelow, B.Sc., A.I.C., and E. Bowes, London: The British Portland Cement Research Association, 6 Lloyds Ave., E. C. 3. Paper; 6 x 10 in.; pp. 23.

WATER POWER SURVEY OF SURRY AND WILKES COUNTIES—By Thorndike Saville, Hydraulic Engineer. Raleigh, N. C.: North Carolina Geological and Economic Survey. Paper; 7 x 10 in.; pp. 41; folding maps.
The first of a series of reports on water powers of counties made by the co-operation of the State and the respective county commissioners.

Letters to the Editor

Protecting Bridges from Automobiles

Sir—Your comment on the new danger to highway truss bridges through being struck by automobiles, as expressed in *Engineering News-Record* of Dec. 21, p. 1054, suggests the advisability of equipping such bridges with skid beams or guard rails carried along the inner face of each truss. In this way the automobile would be prevented from striking an individual member and the force of its blow would be distributed. Even if the skid beams were bent or broken by a car striking them at a sharp angle they would still protect the truss members from direct impact. This method would seem to afford a high degree of protection at low cost.

Such skid beams have been used on important railway bridges to prevent derailed cars from striking the truss members. I have also seen home-made skids applied to one truss of a highway bridge where the approach was at an angle with the bridge. In this case the condition of the skid (a single horizontal angle) showed that it has served its purpose.

Careless or reckless driving and steering of automobiles and motor trucks is a practical condition to be considered by the highway engineer. A certain stretch of road has a series of concrete culverts with heavy pipe handrailing on each side of the road. Although these structures are of recent construction, every one of them has both handrails bent outward and distorted. Since none of them were carried away it is probable that they were struck glancing blows, perhaps as a speeder tried to pass another vehicle.

Chicago, Dec. 23, 1922. BRIDGE GUARD.

Tar Paint and Galvanized vs. Black Steel

Sir—Permit me to add a little from experience on the subject of painting galvanized steel. The Cheesman-Elliot Co. in your issue of Dec. 14 says, "Why Galvanize?" Here is one reason why: A neighbor of mine put up a steel garage of painted corrugated steel. At the same time I put up a galvanized steel garage and painted only the roof and the laps on the sides. In a year or two my neighbor had to renew the roof, as it was all riddled with holes. He has not very much left now but rust, after 4 or 5 years. Mine is practically as good as new. The only place where it rusted is where I bent the sheets at the corners.

If corrugated sheets are bent before they are galvanized they will resist the weather for a long time, particularly on vertical surfaces where the beating of the rain is less severe. I have used galvanized flat sheets for many years for roofs of buildings in the country and have found them to last almost indefinitely. But I have always painted them, not, however, with oil paint. I have also several boats made of galvanized steel and have never had any of them rust through except where bad dinges broke off the galvanizing.

The paint that I always use on these roofs is coal tar paint, when I can get it. Sometimes I have to take asphalt paint at a higher price. The most satisfactory paint I ever used was coal tar paint at 50c. per gal. It sticks to galvanized steel better than anything else I ever tried, and the time to paint it is just when it is placed on the roof or side of a building, regardless of whether it has weathered or not.

There is no theory about this. I bought some "black" iron and some galvanized steel about 10 or 12 years ago and put them both on the same roof. The "black" iron was painted red when I bought it. I had to replace every square foot of it years ago. The galvanized sheets, which I painted with coal tar paint, are still practically as good as new. I have yet to find a spot rusted through.

I have three buildings and part of a fourth roofed in this same manner at Godfrey Station, Pa., and would be glad to show them to anyone who wants to see what galvanized steel painted with tar paint will do. Come in the summer.

Pittsburgh, Dec. 23, 1922. EDWARD GODFREY.

Arch Dam Measurements

Sir—In *Engineering News-Record*, Nov. 30, 1922, there appears an article by Fred A. Noetzli on "Arch Dam Temperature Changes and Deflection Measurements."

In this article some deflection measurements of the Salmon Creek Dam, Alaska, are given and some speculation is made on these deformations. According to Mr. Noetzli's calculations and formulas this dam should have cracked horizontally in several places, otherwise this particular case would not fit the formula.

To the actual observer there are no visible cracks. Although there is no drainage tunnel in this dam where leakage can be directly observed, there are 3 vertical holes in each of the two contraction joints. These holes were put in for the purpose of grouting, but up until 2 years ago grouting had not been done; the water had not been low enough to cause the joints to open and make grouting feasible. The leakage always was zero commercially, which it would not have been had there been any horizontal cracks. During the last two years the writer has not followed the performance of this dam but does not believe that any horizontal cracks could have developed as there are absolutely no reasons why they should; this work was a first class construction job.

It is impossible to calculate an arch dam accurately unless shear and cantilever action can be eliminated or nearly eliminated (not neglected). This can be approximately but not fully accomplished by grouting the contraction joints under pressure. Then whatever shear there may be in the structure with reservoir empty is in the opposite direction from what it will be with reservoir full. In this way shear and cantilever action are at least greatly reduced in amount by reducing the deflection from the vertical position of the dam.

When a dam is so constructed that with reservoir full the deformation in a down-stream direction becomes smaller than is now general, then it is permissible to raise the allowable stress above say 350 lb. per square inch, which stress may now be regarded as the upper limit for conservation design.

Professor Cain's formulas for arch dams are very likely the most accurate brought out, and if shear and cantilever action can be kept low, are perhaps as accurate as formulas for this complicated problem can be expected to be.

San Francisco, Calif., Dec. 26. LARS JORGENSEN.

Much Ado About Nothing—but Dams

Sir—The inane discussion in your issue of Dec. 21 and earlier as to what the height of a dam is, reminds me of an old English conundrum which ran as follows: If it takes a yard of soap to make a flannel waistcoat for a pig, how far is it from St. Paul's to Christmas Day? The answer, I believe, was twelve shillings and sixpence.

Before this momentous question, as to the height of a dam, is settled, I should not be at all surprised to hear that the Arrowrock Dam is really 352.562 ft. in height and not 351.000 as reported, inasmuch as the latter height was measured from a projecting rock on the ground line, now found to be loose.

Why not start a discussion as to what the height of a building is? The question as to whether the foundations, basement floor, natural ground, filled ground, or sidewalk should be the datum would no doubt lead to an endless argument. Then we might try to decide what the height of a mountain is; maximum, minimum or mean? After that, I don't think we should have any difficulty in deciding what the height of folly is.

As to the engineer who avers that "A Dam Is as High as It Dams" I hasten to reply, "Not by a Dam Site."

Denver, Colo., Dec. 29. E. CLINTON JANSEN.
Chief Engineer, the Colorado Power Co.

[Does our correspondent think that by mere levity he can end a discussion that goes back to the first lofty structure on record? Has it occurred to him that the confusion of tongues had as its main topic a question as to the real height of the Tower of Babel?—EDITOR.]

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Charles F. Loweth Elected Am. Soc. C. E. President

Has Been Chief Engineer of Chicago, Milwaukee & St. Paul Ry. For Past 12 Years

Charles F. Loweth, newly-elected president of the American Society of Civil Engineers, has been chief engineer of the Chicago, Milwaukee & St. Paul Ry. since December, 1910. From the same date to Jan. 1, 1913, he was also consulting engineer of the Chicago, Milwaukee & Puget Sound Ry., now operated as the Puget Sound lines of the Chicago, Milwaukee & St. Paul Ry. In his present position he has general supervision of all the engineering, except that of the mechanical department, on more than 10,000 miles of railroad.

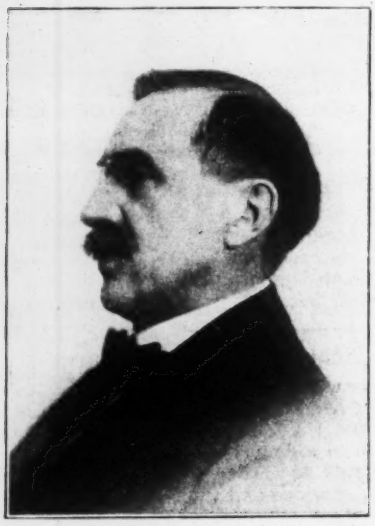
The ballot, canvassed yesterday morning, revealed a total of 2,581 votes cast, of which number Mr. Loweth received 2,564. The other officers elected were: Vice-president, Zone 2, George S. Davison, 2,416 votes; vice-president, Zone 3, Anson Marston, 2,447; directors: District 3, Glenn D. Holmes, 2,393; District 5, E. B. Whitman, 2,402; District 7, George H. Feukell, 2,413; District 8, T. L. Condron, 2,414; District 9, R. N. Begien; and District 12, George C. Mason, 2,396.

Born March 3, 1857, at Cleveland, Ohio, Mr. Loweth received his education at Oberlin College, Oberlin, Ohio. He began his enginneering experience in 1876 as rodman on surveys of the Cleveland, Lorain & Wheeling Ry., now part of the Baltimore & Ohio R.R., and was later employed as draftman for the Atchison, Topeka & Santa Fe R.R. In 1881-1882 he was engaged as an engineer in the construction of the Des Moines & Northern and St. Louis, Des Moines & Northwestern Railroads (now parts of the Chicago, Milwaukee & St. Paul Ry.) In 1882-1883 he was engineer with Raymond & Campbell, bridge builders, Council Bluffs, Iowa.

From 1883 to 1901 he was in business as consulting civil engineer in St. Paul, Minn. During this period he designed and supervised the construction of water-works, sewarage and electric lighting systems for more than 100 municipalities throughout the Northwest, as well as a large number of bridges for various railroads, cities and counties, extending from Michigan to Oregon. During this period he was also consulting engineer on bridge construction for the Northern Pacific R.R., the Minneapolis & St. Louis Ry., the Minneapolis, St. Paul & Ste. Marie Ry., the Chicago, Milwaukee & St. Paul Ry. and several others, and chief engineer for the South St. Paul Belt Ry. and Davenport, Rock Island & North Western Ry. In March, 1901 Mr. Loweth became engineer and superintendent of bridges and buildings of the Chicago, Milwaukee & St. Paul Ry. at Chicago.

Mr. Loweth has always taken a prominent part in technical society activities. He has served as a director and vice-president of the American Society of Civil Engineers. He is a past president of the Western Society of Engineers, and served as treasurer and two terms as director of the American Railway Engineering Association. He maintains a membership in the American Society for Testing Materials. The Civil Engineers' Society of St. Paul claims him as a member and past president. As representative of the American Society of Civil Engineers on Engineering Council he performed a notable service.

Elected President of Am. Soc. C. E.



Charles F. Loweth

War Fraud Suits Are Basis of Am. Soc. C. E. Resolution

At its meeting held on January 17 the American Society of Civil Engineers unanimously adopted resolutions expressing its concern over the indictment of several members of the Society, and the institution of civil suits to recover alleged fraudulent expenditures in connection with war construction. The resolution also urged that, in the interests of justice and in accordance with constitutional guarantees, defendants be immediately tried so that if any be guilty, punishment may be imposed, and if innocent, accusations may be lifted. The resolution provided also that copies be sent to President Harding, Attorney General Daugherty, and to presiding officers of the Senate and House of Representatives.

Am. Soc. C. E. To Vote Again on F. A. E. S. Affiliation

Arguments For and Against Membership To Accompany Ballots To Be Sent Out Feb. 15

At the meeting of the Board of Direction of the American Society of Civil Engineers held January 15 and 16 on the eve of the annual meeting of the Society, it was voted to call for another referendum of the membership as to whether the Society should affiliate with the Federated American Engineering Societies. When the matter was brought to the attention of the annual meeting yesterday morning the Board's recommendation was approved and the president and Board of Direction were instructed by a unanimous vote to send with the ballots arguments why the Society should or should not join the Federation. These arguments are to be prepared by two committees: one composed of three directors who favor affiliation with the Federation, and the other to contain three directors who oppose membership in it. Ballots will be mailed the Society membership Feb. 15 and will be canvassed 50 days thereafter. At the 1922 autumn meeting held in San Francisco the Board expressed a favorable attitude toward joining the Federation, provided the financial situation of the Society should warrant it. The outgoing Board has now recommended to the incoming Board that the budget for 1923 provide the necessary appropriation for membership in the federation during the last nine months of 1923.

The outgoing Board recommended to the incoming Board the appropriation of a sum sufficient to provide an allotment of $2 per member for local sections. A proposal was first considered to make the appropriation large enough to allow a $3 allotment, but it was defeated.

In the interest of economy a proposal for a conference of local sections was defeated. It was decided also on the ground of economy to discontinue the publication of the preliminary notice of applications for membership as a separate pamphlet and to include this information in the Proceedings.

The April meeting is to be held at New Orleans on April 18, 19 and 20.

The Board approved the formation of three technical sections, on: Power, Highways, and Irrigation, in addition to that already existing on Sanitation.

Greetings were received from the Engineering Institute of Canada.

C. E. Beam was elected assistant secretary of the Society. He had served since 1918 as assistant to the acting secretary. Mr. Beam is a B.S. in civil engineering of the University of Washington, class of 1914, and did survey, reclamation and highway work in Yakima and Walla Walla Counties, Wash., from 1914 to 1918.

The services of Eleanor H. Frick with the Society for 25 years were recognized and resolutions of appreciation were adopted.

New Honorary Members, American Society of Civil Engineers

SIR MAURICE FITZMAURICE

Sir Maurice Fitzmaurice, author of a number of technical books, former president of the Institution of Civil Engineers of Great Britain, and internationally prominent through his achievements in bridge engineering and irrigation and drainage work, was born in 1861. He was educated at Trinity College, Dublin, receiving degrees of M.A. and M.E. from Dublin and LL.D. from Birmingham.

He was apprenticed to the late Sir Benjamin Baker, who also was an honorary member of the American Society of Civil Engineers. From 1901-12 he was chief engineer to the London County Council, and from 1912-18 served as chairman of the Admiralty Advisory Committee on Naval Works.

During the World War and subsequent thereto Sir Maurice Fitzmaurice held numerous governmental positions. During the war he was lieutenant-colonel of engineers in the Engineer and Railway Staff Corps and made two visits to the British front in Flanders at the request of the War Office, to advise on questions of drainage. During 1913 he made a trip to Australia to advise on naval harbors.

Sir Maurice has been engaged in various consulting work including that of the Forth bridge. He was also consulted regarding railways and docks in Canada, the Blackwell tunnel and the Nile reservoir dam at Assouan, Egypt.

From 1916-17 he served as president of the Institution of Civil Engineers. He is also a member of the Institution of Mechanical Engineers, an honorary fellow of the Society of Engineers, an honorary member of the Royal Engineers Institution, member of the Engineering Institute of Canada, vice-chairman of the Engineering Standards Committee, vice-chairman of the Institute of Transport and member of the Advisory Council on Scientific and Industrial Research.

In 1912 Sir Maurice was knighted. He has also received various orders, medals, etc., from the government as well as from British technical associations. He is the author of books on "Plate Girder Railway Bridges," "The Thames and Lea," "London County Bridges," "Main Drainage of London."

LEON JEAN CHAGNAUD

Leon Jean Chagnaud, who was born in a small town in the Department of Creuse, France, and was educated in the *Ecole des Arts et Metiers* at Chalons-sur-Marne, is perhaps best noted for his subaqueous and tunnel construction work. Shortly after his graduation he reconstructed the locks of the Canal du Centre and established the massive concrete fortifications about Toul. One of his professional achievements was the excavation for one of the trunk sewers of Paris. In this work he was largely responsible for the development of the modern method of shield tunnelling for subterranean and subaqueous excavation. On this job the first use in Paris was made of shield tunnelling.

Another of his engineering achievements was the construction of that branch of the Paris subway which extends from the Porte de Clignancourt to the Porte d'Orleans. For the execution of this difficult construction, he was rewarded by the Prix Berger and the bestowal of the Legion d'Honneur.

M. Chagnaud has served the state as a member of the Senate. In 1921 he was president of the Society of Civil Engineers of France.

WILLIAM CAWTHORNE UNWIN

William Cawthorne Unwin was born on Dec. 12, 1838, at Coggeshall, Essex, England. He was educated at the City of London School and was a pupil of the late Sir William Fairbairn. From 1861-68 he was manager of engineering works, and from 1868-72 instructor at the Royal School of Naval Architecture and Marine Engineering at Kensington. For the next thirteen years he was professor of hydraulic engineering at the Royal Indian Engineering College, Cooper's Hill, and during the ten years following that, professor of engineering, Central Technical College of the Guilds of London.

He was secretary of the International Commission on the Utilization of Niagara, and in 1891 was president of section G of the British Association. In 1894 Professor Unwin was a member of the Council of the Royal Society and in 1911 president of the Institution of Civil Engineers. He also served in 1915-16 as president of the Institution of Mechanical Engineers. From 1915-18 Mr. Unwin was a member of the Management Board of the Metropolitan Munitions Committee. From 1900-05 and since 1911 he has served on the Senate of London University.

Mr. Unwin was awarded the Kelvin Medal in 1921 and has had conferred on him the degree of LL.D from Edinburgh. He is also a fellow of the Royal Society, member of the Institution of Civil Engineers, honorary life member of the Institution of Mechanical Engineers, honorary member of the American Society of Mechanical Engineers, and honorary associate of the Royal Institution of British Architects.

He is the author of various technical books and has contributed articles on hydraulics and bridges for the Encyclopedia Britannica.

He is professor emeritus of the Central Technical College, City and Guilds of London Institute.

JOHN FRANK STEVENS

John F. Stevens, who has earned an international reputation in railroad engineering and planning, was born in West Gardiner, Me., April 24, 1853. He was assistant engineer, City of Minneapolis, Minn., from 1874 to 1876; became chief engineer of the Sabine Pass and Northwestern Ry. in 1876; and acted as assistant engineer for the Denver and Rio Grande Ry. in 1879, and the Chicago, Milwaukee and St. Paul Ry. from 1880 to 1882.

Mr. Stevens was division engineer for the Canadian Pacific Ry. from 1882 to 1886, when he returned to the Chicago, Milwaukee and St. Paul as assistant engineer. For the two years following he was principal assistant engineer of the Duluth, South Shore and Atlantic Ry., when he became assistant engineer of the Spokane Falls and Northern.

Mr. Stevens' next position was with the Great Northern as principal assistant engineer, being successively promoted to assistant chief engineer in 1893, chief engineer in 1895, and general manager in 1902. In 1903 he joined the staff of the Chicago, Rock Island and Pacific Ry. Co. as chief engineer, and became second vice-president in 1904. From 1905 to 1907, Mr. Stevens was chief engineer of the Panama Canal; and in 1907 acted as chairman of the Isthmian Canal Commission.

In 1907 he became vice-president of the New York, New Haven and Hartford R.R. and had charge of operation. From 1909 to 1911 he became president successively of the Spokane, Portland and Seattle Ry., the Oregon Electric Ry., the Oregon Trunk and the Pacific and Eastern. He was head of the American Railway Mission to Russia in 1917, and acted as director of a corps of railway experts in Manchuria.

Mr. Stevens is an honorary member of the Association of Chinese and American Engineers, and president of the Inter-Allied Technical Board supervising the technical and economic operation of the Siberian and Chinese Eastern Ry., with headquarters at Harbin.

CLEMENS HERSCHEL

Clemens Herschel, past-president of the American Society of Civil Engineers and a former director and vice-president, and inventor of the Venturi meter, was born in 1842 and was graduated from the Lawrence Scientific School of Harvard University in 1860. He then went abroad to pursue further engineering studies in France and Germany.

Returning to the United States he undertook various engineering work, chiefly in New England, giving much attention to bridge work and in 1875 he published a treatise in continuous revolving drawbridges. He was connected at one time with the Boston Sewer Department and served for two years as a member of the Massachusetts Railroad Commission. After a period of service under the late James B. Francis he was appointed in 1879, to the position of hydraulic engineer of the Holyoke Water Power Co. He constructed the Holyoke testing flume and established a system of metering and of recording water consumption of the turbines in the Holyoke mills. The need of an instrument for accurately measuring the

flow of water in large pipes led to his invention of the Venturi meter. For a paper upon this invention and its uses he was awarded the Thomas Fitch Rowland prize of the society in 1888. He also received the Elliott Cresson gold medal of the Franklin Institute of Philadelphia for the same invention.

In 1889 he was made chief engineer of the East Jersey Water Co. Later he served on the commission that made a report on the practicability of the deep rock tunnel plan of distribution of the Catskill water in New York.

Mr. Herschel served as treasurer of the Boston Society of Civil Engineers from 1874 to 1880, and was president of the society in 1890-91. He is also a member of the Institution of Civil Engineers of Great Britain.

He has published a translation of "Frontinus and His Two Books on the Water Supply of Rome A.D. 97." The "One Hundred and Fifteen Hydraulic Experiments," another treatise on hydraulics, was published by Mr. Herschel in 1897.

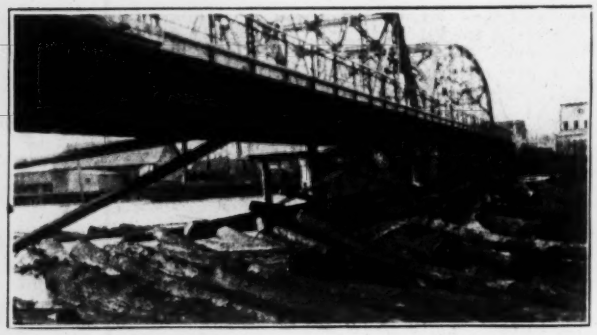
Chance for Outside Contractors on Milwaukee Sewer Work

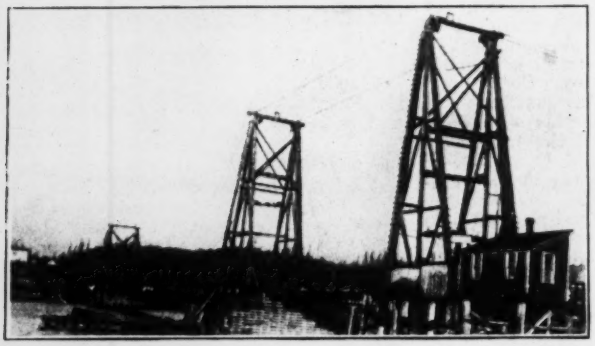
Sewer contracts at a total estimated cost of $2,500,000 are to be let soon at Milwaukee under what T. Chalkley Hatton, chief engineer of the Milwaukee Sewerage Commission, believes are conditions favorable to contractors and which, in view of the amount of work now in hand by local contractors, afford a special opportunity to outside contractors. Mr. Hatton has sent the following statement for publication in *Engineering News-Record*.

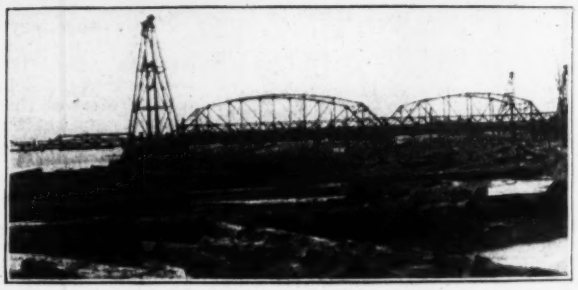
"The Sewerage Commission of the City of Milwaukee and the Metropolitan Sewerage Commission of the County of Milwaukee, both of which are operated under the same engineering staff, purpose, within the next two [illegible], letting contracts for building [illegible] miles of intercepting sewers ranging in size from 24 to 88 in., the tunnelling of which will be built in tunnel [illegible] under city streets and partly through suburban districts. There will be twelve contracts ranging from $100,000 to $600,000 each, and aggregating about $2,500,000. Bids will be received from week to week until all are covered. Bid advertising will begin about Feb. 1.

"The money is on hand to pay for this work in cash as it progresses. There are no political connections or labor affiliations to hamper or embarrass contractors. Most of the local contractors, competent to carry on this class of work, are pretty well tied up with present contracts with the two commissions, and it is a good opportunity for competent outside contractors with good organization and equipment to secure reasonably profitable contracts."

Rusted Anchorage Cables Believed Responsible for Failure of Kelso Suspension Bridge







Falsework of an uncompleted new bridge downstream of the suspension bridge (see left upper view) caused a log jam which shoved against the pile piers of the old bridge (right upper view, showing upstream side), but this jam was cleared several days before the collapse and is not believed to have contributed to the failure. The piers of the old bridge are still standing, apparently intact except for such damage as would be done by the falling towers.

The suspension system of the old bridge (seen from downstream and upstream respectively in the two middle views) broke in the anchorage of the upstream cable at the east end (right-hand end of left-hand view). The five anchorage ropes of the upstream cable show marked deterioration below ground. Tests of these are being made.

F.A.E.S. Council Reports Progress at Meeting

Activities of American Engineering Council Cover Matters of Public Interest

Sixty delegates responded to the roll call of the annual meeting of the American Engineering Council of the Federated American Engineering Societies at Washington, Jan. 11-12, and discussed the reports of the various committees. Action of the Council at the meeting comprised the election of officers, a resolution recommending that the Department of Commerce report facts on business conditions, and recommendations that the Federal Water Power Commission be given a larger personnel, and that the Patent Office be given further relief. The rest of the sessions consisted in transmission to various committees of the Council of different proposals and listening to the reports of the president, the secretary, and some of the committees, the most important of which was the public affairs committee.

Progress Made

Both the president and the secretary emphasized the fact that the Council and the F.A.E.S. were progressing gradually and surely toward the fulfilment of their missions and that they were becoming an increasingly greater power in Washington. In this connection the Committee on Public Affairs reported that it had considered the following subjects: The Great Lakes-St. Lawrence waterway, national parks, proposed tax on foreign books in English, appointment of an engineer on the Civil Service Commission, Department of Public Works, international standard rating system, ship subsidy bill, hydraulic laboratory, regulation of trade associations, Merchant Marine Act, Bacharach Bill, revision of mining law, and the appointment of a successor to Dr. Stratton as director of the Bureau of Standards. The committee on study of the business cycle called attention to the necessity of bringing to the attention of the business executive the facts regarding statistics of business for the purpose of aiding him in forecasting, and suggested also that the Department of Commerce establish an agency for the forecasting of business conditions and for the distribution of such information. As stated above, however, the meeting changed this suggestion to a recommendation that the department furnish facts and not forecasts. The committee on industrial ideals suggested that engineering colleges give an increased attention to the social aspects of engineering activities.

There was discussion of the possibility of increasing the size of the bulletin and the taking of advertising therein, which resulted in a resolution to refer the whole question to the executive board.

After describing a number of the more important engineering projects now under contemplation in Italy, he wound up with a suggestion that the engineer can be a better interpreter of international amity than any other man, because his life has been devoted to the development of those things of each nation that the other nations need and want. This idea was expanded by

(*Continued on p. 136*)

Revise Structural Steel Stresses

Working stresses and a specification for structural steelwork were considered on Jan. 5 by a board of engineers called together by the American Institute of Steel Construction. The board, consisting of Prof. M. S. Ketchum, E. R. Graham, W. J. Watson, W. J. Thomas, and Prof. Geo. F. Swain, met at New York (Mr. Graham absent) and agreed on revision of the now current working stresses. A design specification was drafted and discussed. It is now being put into final form, and according to expectations will be completed and definitely adopted within a few weeks.

Bennett Will Retire July 1

Charles J. Bennett, for the past ten years state highway commissioner of Connecticut, will retire at the expiration of his present term, July 1, and assume the general managership of the Edward Balf Co., Hartford, a firm which does a general contracting and stone-crushing business. Mr. Bennett has declined reappointment as highway commissioner, though he is presumed to be willing to act as a member of a commission which the legislature may authorize. Mr. Bennett has been prominent among highway officials and in highway engineering work for many years, having taken an active part in the sessions of both the American Association of State Highway Officials and the American Road Builders Association.

Mr. Bennett's early professional experience was secured in upper New York State where he was engaged in private and public work. He was also employed by the Rochester Ry. Co., the Terminal R.R. of Buffalo and the Buffalo, Rochester & Pittsburgh Ry. For 12 years Mr. Bennett was in the office of the New York State engineer and surveyor, most of the time on barge canal work. During the latter part of this period he was in general charge of the Albany office.

Franchise Awarded for Carquinez Straits Bridge

The supervisors of Contra Costa County, Cal., on Jan. 8 awarded the Rodeo-Vallejo Ferry Co. a franchise to construct a bridge across Carquinez Straits between Morrow Cove and Valona. Two other applications for constructing a bridge in this vicinity made by the San Francisco Transit Co. and the Dillon Point Development Co., respectively, were denied. Previous reference to all three proposals was published in *Engineering News-Record*, Nov. 30, 1922, p. 949.

The terms of the franchise are that the company shall start construction within four months and complete the bridge within three years and shall post a bond of $50,000 to guarantee fulfillment of all requirements. The terms were all accepted by the applicant. Announcement was also made at this meeting that an agreement had been reached between the Rodeo-Vallejo Ferry Co. and the California Hawaiian Sugar Co. whereby the latter withdraws opposition to the location of the proposed bridge piers. Agreement on this point is believed to have been a prerequisite to approval of the project by the United States War Department.

Overdevelopment Basic Evil, Says Coal Commission

Labor and Transportation Troubles Hinge on Seasonal Demand and Surplus Mines and Workers

Overdevelopment and irregular demand are declared by the President's coal commission, in its first preliminary report, to be paramount difficulties besetting the coal industry. To variation in demand are charged the part-time operation in the bituminous mines and transportation difficulties in the handling of coal to the consumer.

The commission, though not yet in possession of enough facts from which to form valid conclusions, reports, however, that it has perfected an organization and gathered much data. When the vital factors have been determined hearings will be held and field investigations carried on to determine what are the facts with respect to these issues. In this way the commission hopes to avoid wasting time in the investigation of collateral issues. After this process it will be in position to formulate its recommendations to Congress.

Telegrams Are Published

In its report the commission publishes the telegrams it exchanged with the operators and miners while they were in conference at Chicago in early January trying to reach an agreement as to future wage-scale making. In these the commission urged that should negotiations fail both parties should agree to continue for another year the scales now in force. The conference broke up without an agreement, but a further session is scheduled for today in New York. In the report the commission states that it "has reason to believe that an agreement will be reached in the near future that will avert any widespread cessation of mine operation in the union fields on April 1, thus assuring the needed coal supply for at least another year."

The farreaching importance of the investigation is summed up by the commission in the following concluding paragraph of its report:

"The inquiry involves the whole question as to what is best for the people, free competition, government or private ownership, regulation or control in the coal industry. Should the operators in given areas be permitted to combine so that the low-cost mines would furnish the product to the people and the high-cost mines be kept in abeyance to meet an emergency properly regulated as to price and profit by some governmental agency, or should this prime necessity of life and business be left wholly to open competition in the market? This problem is of so great moment with reference not only to theories of government but also to the economic life of the republic that the view of the commission is left to its final report.

"The commission believes that the public interest in coal raises fundamental questions of the relation of this industry to the nation and of the degree to which private rights must yield to public welfare. It may be that both private property in an exhaustible resource and labor in a public service industry must submit to certain modifications of their private rights, receiving in return certain guarantees and privileges not accorded to purely private business or persons in private employ."

Seven Bronze Towers to Relieve New York Traffic Congestion

Six more traffic towers, like the one recently unveiled at 42nd St. and Fifth Ave., New York City, and shown herewith, are soon to be erected at strategic traffic points, replacing old towers. The towers are the gift of the Fifth Ave. Association to the City of New York.

Each tower is almost entirely of bronze with a granite base 4 ft. square and 3 ft. high, and securely bolted to a

BRONZE TOWER CONTROLS TRAFFIC

concrete foundation. The tower is 28 ft. high and the lower part is open to permit an unobstructed view up and down the street. The space occupied by the traffic officer is inclosed in glass. The tower is heated with an electric stove. Around the base of each tower are laid granite striking blocks which fend off traffic and protect the tower.

The design for the tower was selected from among 130 designs submitted in a prize competition, the Fifth Ave. Association offering prizes of $500, $300, and $200, for first, second, and third places, respectively.

Turner to Study Detroit Traffic

The Transit Commission of the City of Detroit is to have a traffic survey made under the direction of Daniel L. Turner, consulting engineer for the New York Transit Commission. It is estimated that the work will take about a year. Mr. Turner will make a report on the transit conditions as he finds them with recommendations, and the survey will include also a consideration of the Detroit suburban transit situation.

F.A.E.S. Council Reports Progress at Meeting

(*Concluded from p. 135*)

Calvin W. Rice, of the American Society of Mechanical Engineers, in describing the recent South American Engineering Congress and by Elmer A. Sperry, in describing the conditions today in Japan as observed in a recent trip to the Orient.

One of the most interesting features of the meeting was the banquet on Jan. 11, which was attended by ninety-one guests. On that occasion, the principal address was made by Ambassador Caetani, the engineer whom Italy has sent to the United States to be near this government. Ambassador Caetani said, among other things:

"Your kind invitation made me feel that, besides sailing for America as Italy's Ambassador, I was going home to my old stamping grounds somewhat still invested with the qualifications of an engineer. We pride ourselves in saying: 'Once an engineer, always an engineer.' Whatever may be the course of life followed by one of us, it will always be marked by the indelible seal of the scientific, practical and logical training to which an engineer is subjected during the early years of life.

"I judge that many of the colleagues present have followed in life most disparate occupations which often had little to do with engineering; such has been my personal experience during the agitated years since the beginning of the war. We can say that in each and every occupation we have felt and thought and acted chiefly as engineers."

Some Dissatisfaction Voiced

During the course of the business sessions, some dissatisfaction was voiced with the conduct of the affairs of the Federated Societies. The point was made that member societies had too little voice in what was being done and some fear was expressed that an effort might be made to make of the Federation a super-society. It was pointed out by President Cooley and by L. W. Wallace, the executive secretary, that every effort has been made to conduct the Federation so that it would be a sort of House of Representatives—highly responsive to, and in no way dominating, constituencies. Certain other functions of the Federated Societies were likened to that of an embassy in Washington, representing member organizations. It was established that ample opportunity has been afforded to the membership of the member societies to acquaint themselves with all details of the Federation's activities. In the end, the difficulties were ironed out and the general discussion by members of the Council indicated a complete sympathy with the broad purposes of the Federation but emphasized the need of devising every means possible to acquaint the individual engineer, as well as the member societies, with the work completed and problems to be undertaken by the Federation and its committees.

M. E. Cooley, of the University of Michigan, was re-elected president for the ensuing year. The vice-presidents elected for the Council were J. Parke Channing and Calvert Townley of New York; Philip N. Moore of St. Louis; Gardner S. Williams of Grand Rapids, Mich. L. W. Wallace continues as executive secretary.

Engineering Societies

Calendar

Annual Meetings

AMERICAN CONCRETE INSTITUTE, Detroit; Annual Convention, Cincinnati, Jan. 22-26.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; Annual meeting, Los Angeles, Jan. 30-Feb. 3.

NATIONAL HIGHWAY TRAFFIC ASSOCIATION, New York; Annual Convention, Cleveland, Feb. 19-20.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago; Annual Convention, Chicago, March 13-15.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, Norfolk, Va., May 7-9.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Annual Meeting, Atlantic City, N. J., June 25-29 or 30.

The Engineering Institute of Canada will hold its annual general business meeting at Montreal on Jan. 23, 1923.

The Northeastern Section of the American Society of Civil Engineers will hold its annual meeting, with election of officers, Jan. 27 at the Boston City Club, Boston, Mass. There will be brief talks by men of public affairs on the subject, "Engineers in Business and in Public Positions."

The Iowa Engineering Society meeting, Jan. 23-26, inclusive, has scheduled papers the afternoon of Jan. 24 in all six sections, drainage, highway, mechanical-electrical, municipal, railroad and structural-architectural. All other sessions are general.

The Boston Society of Civil Engineers will have an illustrated paper by Arthur T. Safford, engineer of locks and canals, Lowell, Mass., on "The New Hydro-Electric Development of the Amoskeag Manufacturing Co. at Manchester, N. H.," at its joint meeting Jan. 24 with the Massachusetts Institute of Technology student chapter of the American Society of Civil Engineers.

The New York State Association of Builders will hold its annual convention and election of officers Jan. 30 and 31 at Elmira, N. Y. Stephen A. Smith of Albany is president, and Edward A. Keeler of New York is secretary and treasurer.

Personal Notes

C. A. EMERSON, JR., whose resignation as chief engineer of the Pennsylvania State Department of Health to become associated with Fuller & McClintock in their new Philadelphia office, was recently noted in these columns, has been made consulting engineer of the department named.

W. L. STEVENSON, for the last four years assistant chief engineer of the Pennsylvania Department of Health, has been appointed chief engineer of the department to succeed C. A. Emerson, Jr., who recently resigned. From 1898

to 1905 Mr. Stevenson was engaged on municipal engineering work for the city of Philadelphia, including the construction of the Walnut Lane Bridge. During the next ten years he continued with the city as engineer in charge of sanitary surveys of the rivers and streams; operation of the sewage experiment station; construction and operation of the Pennypack Creek sewage-works; preparation of the comprehensive plan and report on the collection, treatment and disposal of the sewage of the entire city of Philadelphia; and the design, contract letting and beginning of construction of the Frankford Creek high-level intercepting sewer and the grit chamber for the North East sewage-works. During the war Mr. Stevenson was sanitary engineer and assistant director, Department of Health, U. S. Shipping Board Emergency Fleet Corporation, in general charge of water supplies, sewerage and other sanitary engineering work the emergency shipyards and their vicinity.

PAUL D. WRIGHT, of Erie, a farmer by birth, a civil engineer by education, and a manufacturer by occupation, has been appointed commissioner of the Pennsylvania State Highway Department by Governor-elect Pinchot. Mr. Wright, a graduate of Yale, is president of the Reed Manufacturing Co. This is the first time he has held public office. He is 50 years of age.

J. GERALD PHELAN, engineer with the Fletcher-Thompson, Inc., engineers, Bridgeport, Conn., has been appointed commissioner of the building department of Bridgeport. Mr. Phelan succeeds the late Charles H. Botsford, who was building commissioner for twenty years.

HENRY B. SMITH, of Mount Holly, N. J., has been named by the Burlington County Board of Freeholders as county engineer of Burlington County to succeed Harold Wills.

EDWARD L. CRUGAR, district engineer of southern lines, Illinois Central R. R., has been appointed engineer of construction, with headquarters at Chicago. J. W. KERN, JR., roadmaster of the St. Louis division, succeeds Mr. Crugar, with headquarters at New Orleans.

J. G. HALL, who formerly was appraisal engineer with M. E. Cooley, consulting engineer of Ann Arbor, Mich., has become associated with H. Miscampbell, Duluth, Minn., and is in charge of the engineering department.

H. T. HAZEN, who has been acting chief engineer of the Canadian Northern Ry., eastern lines, has been made chief engineer. His new offices are in Toronto.

ALLAN T. BONE, formerly engineer with the George A. Fuller Co. in construction work in Canada, is now with the Shawinigan Engineering Co. on design of equipment and plant layout.

W. G. THOMPSON, former chief engineer of the New Jersey Highway Department, and more recently chief engineer on the construction of the ideal section of the Lincoln Highway, has been made chief engineer of the Bay Construction Co., St. Petersburg, Fla. He is charged with the design, equipment of a force for and the construction of a six-mile private highway toll bridge across Old Tampa Bay between the cities of St. Petersburg and Tampa. The bridge is known as the Gandy bridge, after George F. Gandy, Sr., formerly of Philadelphia, who conceived the idea of the bridge's construction and secured a charter from the Florida Legislature.

J. T. WHITTLESEY, consulting engineer of San Francisco, has been appointed a member of the California State Railroad Commission for a period of two years, filling a vacancy caused by a resignation. Mr. Whittlesey is a graduate of Yale University, class of 1889, and has been a resident of California since 1912. Before going to California he was successively, superintendent of the motor department, Brooklyn (N. Y.) Street R.R.; chief engineer of the Brooklyn Rapid Transit Corp.; superintendent of the Stephenson Car Co., Elizabeth, N. J.; chief engineer of the United Electric Co., Newark, N. J.; and chief engineer of the Department of Public Service Corp. of New Jersey.

EUGENE A. YATES of New York, consulting engineer of the Alabama Power Co., has been appointed general manager of the company, relieving W. N. Walmsley, who has resigned the position of general manager, held for the last seven years, because of poor health. He has been vice-president of the company for two years. On his return from South America, where he went as Alabama's delegate to the Brazilian exposition, Mr. Walmsley will resume his duties as vice president, acting in supervisory capacity. Mr. Yates was chief engineer of the company in the construction of Lock 12 and has given much time to construction of Mitchell dam in association with O. G. Thurlow, the company's chief engineer.

J. J. FLAD, who for several years has been in the employ of the state architect's office at Madison, Wis., has become associated with A. SMALL. They have recently opened an architectural and engineering office at Madison.

D. B. RUSH, who has been associated with the engineering department of Robert W. Hunt & Co., inspecting, testing and consulting engineers, has been appointed manager of the cement department at the general office, Chicago. Mr. Hunt is a graduate of Rose Polytechnic Institute. Prior to his joining the Hunt company he was successively employed by the engineering department of the Chicago & Alton R.R.; Horace G. Burt, civil engineer; W. F. M. Goss, railway engineer; the late John F. Wallace, and Bion J. Arnold.

BRIG.-GEN. WILLIAM BARCLAY PARSONS was chosen chairman of the trustees of Columbia University for the seventh time at the recent annual meeting. During the war General Parsons served with the 11th Engineers regiment, becoming its commander, having risen from major to colonel. After the war he was deputy chief engineer, G. H. Q. Organized Engineer Reserve, U. S. Army. He was made a brigadier-general in 1922.

R. M. MORTON has been selected as state highway engineer of California and head of the state department of public works, succeeding AUSTIN B. FLETCHER, who recently resigned. As chief highway engineer of Sacramento County and more recently of San Diego County, Mr. Morton has constructed some of the most important roads in the state.

STEPHEN A. FOSTER has been appointed street commissioner of Toledo, Ohio, succeeding the late J. W. MCGINNIS.

FRANCIS C. CURTIN, of Syracuse, N. Y., and THOMAS J. MORRISON, of Rochester, N. Y., have been appointed engineers in charge of the middle division and the western division, respectively, of the New York Barge Canal.

Obituary

WILLIAM F. BATES, since 1918 town engineer of Montclair, N. J., died from heart trouble Jan. 10 at the age of 52. Mr. Bates was born in Boston. He was for many years associated with Major Christopher Harrison, then city engineer of Everett, Mass. Major Harrison and Mr. Bates went to Montclair in 1917 as town engineer and assistant, respectively, and when Major Harrison retired in 1918 Mr. Bates became town engineer.

VAUGHAN C. MILLER, superintendent of public works, Lima, Ohio, dropped dead Dec. 12, from heart trouble, while driving a car. He was a graduate civil engineer of Ohio State University and was 33 years old. Mr. Miller had been connected with the city of Lima for the past ten years, as rodman, draftsman, assistant city engineer and city engineer and when Lima took up the city manager form of government he was appointed superintendent of public works.

HILMAR F. SMITH, supervising engineer for the construction service of the Quartermaster Corps, U. S. Army, at Belleville, Ill., died there Jan. 6, aged 30 years. Mr. Smith was a graduate from both civil and electrical engineering courses at Rutgers College. Previous to his employment at Belleville he had been supervising engineer on the construction work done by the Quartermaster Corps at Muscle Shoals, Ala.

HENRY H. LYNCH, engineer and former head of the old cable-car systems in San Francisco, died in that city December 30 at the age of 72. Until a few days prior to his death, Mr. Lynch was in active service as chief engineer of the Peninsula and San Jose Railroads. Mr. Lynch went to California at the age of 52 and for a number of years represented large interests in the work of reclaiming delta lands in the Sacramento river. One of the greatest projects he entered upon occurred through his associations with Ferdinand De Lesseps, in their first efforts to construct the Panama canal.

CHARLES H. BOTSFORD, building commissioner, of Bridgeport, Conn., for the past twenty years, died at his home in that city, Dec. 29, following a brief illness. Mr. Botsford was 70 years old.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

More Suggestions—

For Better Equipment and Repair Parts Service

IN THE Dec. 14 issue was begun a discussion of "Better Equipment Maintenance and Repair Parts Service." Its object is to show how some of the misunderstandings between maker and user of construction machinery can be avoided. This week's contribution is a recital of experiences by a manufacturer of concrete mixers and cranes:

From the Koehring Co., Milwaukee, Wis.

AT THE present time we are manufacturing five sizes of paving mixers and seven sizes of construction mixers. The records, therefore, must be very complete in order that proper repair part service may be given. A thorough and easily read repair list is furnished for all machines so that orders may be placed and filled with a minimum of delay. In case any question arises as to the meaning of an order, the customer is immediately advised by wire and further information is requested, or a repair part list is furnished to him with the request that he furnish part number. Often the repair part list that was sent out with the machine becomes lost or is at the office of the owner instead of being in the field. The superintendent, therefore, in making requisition for the part does the best he can in describing the part that he desires. If, however, in ordering parts, he will give in all instances the machine number and the machine size, which is to be found on the name plate, it will be of material assistance. In case no repair part list is available and no number is found on the part, a sketch showing the exact location of the part, or the part itself should be sent in for duplication.

Owners are giving a great deal more thought to the care and use of their construction equipment than formerly. The mechanics are appreciating the necessity of keeping the machines clean and well lubricated to prevent expensive delays due to breakages.

Each machine should be equipped with an extra set of cables. In fact, many contractors are ordering an extra set of cables sent with the machine. These are then wired to the frame at some point where they will always be accessible instead of in the warehouse.

The machine should be inspected regularly, preferably when closing down for the day and again in the morning, and should receive a very careful inspection once a week. Many contractors find a regular Saturday inspection is desirable, as it allows minor adjustments and repairs to be made on Sunday without delaying the operation of mixing.

In summing up, it is suggested that all users equip their mixers with a complete repair part list, and instruct the operator in the use of this list, so that when parts are needed they can be ordered with a minimum of delay. Further, some individual on the job should be made responsible for complete inspection of the machine each week to make sure that some part is not wearing unduly. He should have authority to order parts if wear is apparent.

(To be continued next week)

Construction Equipment Exported

For the month of October, 1922, the U. S. Department of Commerce reports the export from the United States of 32 concrete mixers valued at $27,485; 228,785 lb. of miscellaneous construction equipment valued at $40,498; and 155 bucket and belt conveyors valued at $32,228.

Japan was the biggest consumer of concrete mixers, 11 units costing $8,835 being shipped to that country; Canada came next with 5, and Mexico third with 4.

During the month Canada received from the United States 73,405 lb. of miscellaneous construction equipment valued at $15,132; Brazil came next with 52,513 lb. valued at $7,032. Conveyor shipments to Cuba amounted to $15,000.

Review of Construction Equipment and Materials During 1922—Part III

DEVELOPMENTS in construction equipment and materials during 1922, as noted in "Engineering News-Record's" review beginning in the Jan. 4 issue, took the form of improvements in details rather than in new types of machines. Previous installments of the review included power shovels, concrete chuting equipment, industrial locomotives, elevating loaders, rock crushers, road graders, mixers, and concrete road building plant. This week additional classes of equipment are covered.

Clamshell Buckets

INCLOSED gearing, to eliminate contact of the material handled with the operating parts, with consequent wear, was the feature on one type of clamshell. Improvements were also made on the multiple sheave reeved type of grab bucket to prevent breakage of the main closing or hinge shaft. One manufacturer reports no material changes in bucket standards, but cites a demand for a great many special buckets to cope with usual conditions of service.

Wellman-Seaver-Morgan Co. EXCESSIVE wear on parts, due to the abrasive action of the material handled, is done away with in the Wellman-Seaver-Morgan Co.'s geared clamshell bucket with all working parts inclosed in a cast-steel casing. This design, it is claimed, departs from the usual design of grab-buckets employing ropes or chains for their operation in that the completely inclosed gearing produces the necessary digging power. This feature also makes possible effective lubrication. The bucket is made in capacities of ¾, 1, and 1½ cu.yd.

Orton-Steinbrenner Co. TO PREVENT the possibility of breaking the main closing or hinge shaft on its multiple sheave reeved type of grab bucket, the Orton & Steinbrenner Co. is now making the hinge shaft in three parts. The center part carries the closing sheaves, is constructed separately and may be removed from the sheave block by two bolts. This design is claimed to have the advantage of permitting the replacement of a worn sheave or bushing without threading the entire shaft. The two end parts of the shaft are pinned in the block, the hinges are cantilevered and made interlocking.

An improvement in the power-wheel bucket has involved offsetting the closing shaft from the hinge shaft. This feature increases the size of the power wheel and adds to the digging efficiency of the bucket.

Locomotive Cranes

TO make the operation of locomotive cranes independent of rails, manufacturers, almost without exception, are furnishing equipment mounted on crawlers. The year's developments were along lines of improving the convertibility of these machines from bucket to dragline, power shovel, or skimmer-scoop work, simplifying operation by reducing the number of gears and clutches, and improving steering facilities. Forged steel gears instead of steel castings above the rotating base and a wider range of traveling speeds were introduced. For great mobility one manufacturer announced a crane designed for mounting on a standard motor truck chassis.

Through their national organization, locomotive crane manufacturers have agreed upon performance standards for standard-gage equipment which now accompany all

specifications issued. The purpose of these standards is to enable the prospective purchaser, when asking for bids, to know that he is receiving quotations upon the same kind of equipment. These standards, among other details, list the minimum safe load for 12-ft. and for 40-ft. radius for cranes with rated capacities of from 10 to 30 tons.

Bay City Dredge Works

CAST-STEEL gears and boxes are now furnished on the model 16 crane where cast iron was formerly used. Other improvements include a cut-steel drive connection to the engine. For road grading a skimmer scoop of ⅝-yd. capacity, claimed to be the largest manufactured for half-circle type of equipment, was introduced; it has a bearing on both the top and bottom of the boom rather than on the flanges of the channel, as was the case with former skimmer scoops. The varied uses to which the company's excavator crane may be put are indicated by its ability to handle seven different kinds of bucket scoop.

A one-man excavator with a ⅜-yd. bottom-dump shovel type dipper was developed to meet the need for a light, economical machine to fill the gap between heavy shovel equipment and hand labor.

Brown Hoisting Machinery Co.

IN ADDITION to crawler and four-wheel railroad truck mountings, the small Brown crane is now mounted on eight-wheel trucks for service on construction work. An improvement made in this equipment was the introduction of a two-speed travel gear, giving it more power, particularly on the crawler traction.

Browning Co.

THE MOST important change in the Browning equipment during the year was in the gears above the rotating face. These are now made of forged steel instead of steel castings. This change is designed to increase the life of the gears and to assure perfect teeth, which, it is claimed, is sometimes impossible with steel castings. The company is just completing a machine mounted on crawler traction.

Byers Machine Co.

TO COMBINE light crane service with ability to move quickly from one job to another, the Byers company designed its Truckrane with a special base to permit mounting on any standard motor truck of 5 tons' capacity or larger. The outfit is designed for use with a ½-yd. bucket and has a maximum operating radius of 20 ft. The weight of this crane without bucket or counterweight is 11,200 lb. These cranes are furnished unmounted.

For the full-circle crane a half crawler mounting—road-wheel steer in front and caterpillars in the rear—is supplied in addition to the full crawler or wheel mountings. On the full-length crawler model the design provides for steering by power from the operator's position. A feature of the equipment is the self-locking bronze worm which allows the boom to be raised or lowered under load in connection with or independently of any other crane operation.

Industrial Works

IN ADDITION to the development of its full revolving crane on crawler treads, the Industrial Works, during 1922, delivered to the Virginian Railway Co. what is claimed to be the largest railroad wreck crane ever built. With all outriggers set it has a capacity of 200 tons at 17½-ft. radius, as against 160 tons, the greatest capacity heretofore. Without outriggers, the crane has a capacity of 42½ tons at 17½-ft. radius. The equipment is mounted on special six-wheel railroad trucks and is operated by steam.

Koehring Co.

ON ITS LARGE crane excavator, designed to handle a 1-yd. bucket at 45-ft. radius, the Koehring Co. introduced a spur-gear drive, friction clutch and double drum, by which it is possible to boom the loaded bucket in and out as often as necessary. This feature, it is claimed, eliminates the necessity of traveling with the crane back and forth when taking or discharging its load. The crane excavator is of the full revolving type, mounted on crawler traction, and is equipped with 100-hp. four-cylinder gasoline engine. It has three speeds forward and one reverse.

Another improvement was in the use of two line speeds on all cranes to facilitate interchangeability from clamshell to dragline work.

Link-Belt Co.

ONE OF THE features of its revolving crawler crane emphasized by the Link-Belt Co. is the fact that only sixteen gears of all descriptions are used as compared with about thirty gears in older types of crane. Equipped with two independent hoisting drums, the machine is suitable both for clamshell and dragline work. The power unit is a 50-hp. gasoline engine for which a 40-hp. electric motor may be substituted.

Orton-Steinbrenner Co.

A WIDE variety of uses is provided for by the interchangeability features of the Orton & Steinbrenner combination locomotive crane and power shovel in sizes of ¾ and 1 yd. Among the year's improvements were, in addition to an auxiliary steam-shovel dipper, a reeved type of dipper shovel and a skimmer scoop attachment. The latter may be suspended from the regular crane boom without detaching it, and is designed for tearing up old pavements or grading work.

In the crawler-tread type of machine a new steering gear has been introduced to permit the crane to be turned while traveling, loaded, irrespective of the relative positions of boom and car body. The steel bevel differential propelling gears are now cut from the solid, instead of being molded, and are placed inside a heavy cast gear case and run in oil.

Pawling & Harnischfeger Co.

FOR CITY use a combined ¾-yd. shovel, dragline and locomotive crane was brought out during the year; it was provided with wheel traction instead of the crawler mounting heretofore used.

A machine handling a ¾-yd. bucket at a 40-ft. radius, developed originally for the U. S. Reclamation Service, was adapted to general construction service. This dragline excavator has four movements forward and reverse on crawler traction. The power unit is a 75-hp. gas engine.

Moore Bros. Crane Co.

A PATENTED gear-shift device on the Moore 1-yd. dragline crane enables a single universal clutch to swing the crane, propel the machine, and raise and lower the boom. The only other clutch is used for the drum. In this way a reduction in the number of shafts, gears, levers, and bearings is secured.

Hoists

DURING the year several manufacturers brought out new lines of small (8 hp.) hoists. On the larger type silent chain belt drives were introduced as well as new automatic brakes. Third-drum attachment may now be obtained for bolting onto two-drum units for work with excavating buckets or draglines.

Clyde Iron Works

THERE WAS added to the Clyde equipment during the year a line of small gasoline hoists of from 8 to 15 hp. The motor is complete with radiator, fan-cooling attachment and all accessories. Power transmission from the engine to the hoisting drum is through a silent belt chain drive. On the company's builders' hoist of this type a reversible elevator sheave is furnished which can be operated independently from the friction drum.

Mead-Morrison Mfg. Co.

A NEW engine was designed with patent automatic brake especially adapted to three-drum hoists for grab-bucket operation. The mechanism is such that the brake may be allowed to grab at its full power, checking the load without jar on the machine or rope. This brake has been standard equipment on the company's motor truck winches and in future will be furnished on its new hoists. All hoists are being equipped with asbestos frictions and asbestos-lined brakes.

New hoists are made with two drums; a detachable third drum is available for bolting to the two-drum units if needed. The manufacturers point out that a contractor standardizing on this equipment may own perhaps a dozen two-drum outfits and several third-drum attachments, thus providing for three-drum operation at a minimum initial investment for plant.

J. S. Mundy Hoisting Engine Co.

THIRD-DRUM extensions for double-drum hoists have been developed for work involving the use of buckets and draglines; they may be bolted to the main frame of standard hoist units. On electric hoists a patented locking device is installed by means of which a load is prevented from falling in case the current is cut off. Other recent improvements provide for the use of non-burning friction blocks instead of

wood blocks and the coring out of the brake flanges in order to air cool the brakes.

To increase the service of two- or three-drum hoists a patented swinging drum is now furnished for operating the bull-wheel of a derrick. It is detachable, like the third-drum extension above noted.

Pawling & Harnischfeger Co. GAS-ENGINE hoists ranging from 8 to 110 hp. were added to the Pawling & Harnischfeger line of construction equipment. These hoists are furnished also with electric motors or for belt drive. On the gasoline hoists the engines are four-cylinder vertical tractor types.

Gasoline Engines

AS a source of power for operating construction plant the gasoline engine has developed into a widely used type of equipment. On contracting work now it is no novelty to see such a diversified range of plant as concrete mixers, industrial locomotives, pumps, hoists tractors and trucks, road rollers, power shovels, locomotive cranes, elevating conveyors, and a host of other equipment operated by internal combustion engines. In adapting their engines to the varied types of plant, manufacturers have introduced improvements insuring reliability of operation, elimination of vibration, and lowered operating costs. There is a growing demand for multiple-cylinder gasoline engines in the construction field. Even on the small-capacity concrete mixers for one-bag batches, two-cylinder engines have been substituted for single-cylinder units, while on mixers of larger size (½ yd. or more in capacity) four-cylinder gasoline engines are replacing steam engine and boiler outfits.

Buda Co. IN ORDER to take advantage of the flexibility and general utility of the four-cylinder type of gasoline engine, the Buda units are being mounted on either structural steel or cast-iron bases and equipped with all needed accessories. These units are being supplied with and without radiator equipment in connection with the operation of centrifugal pumps where water from the pumping operation itself is utilized for cooling the engine.

Other developments include provision for taking off the drive directly in line with the engine or at right-angles to it. Reducing and accelerating gears are used to adapt the speed of the driving end to specific requirements. By means of a flexible coupling a direct connection to the flywheel may be made, a type of installation adapted particularly to cases of gas-engine-driven electric generating units.

On its electric generating units the company has installed a number of safety features, including an over-voltage relay which stops the engine in case anything happens to the governor controlling the speed.

Novo Engine Co. A GASOLINE hoisting *unit*, as opposed to a hoist coupled to a gasoline engine often unsuited for such purposes, was announced by the Novo Engine Co. The unit is a four-cylinder outfit intended for use on heavy construction operations. The engine is completely housed. Its speed of 1,000 r.p.m. is less than that of the automotive type engine. Two flywheels are furnished to insure uniform power output.

Wisconsin Motor Manufacturing Company THERE has been no radical change in the Wisconsin line of equipment, except the addition of a new 4 x 5-in. four-cylinder over-head valve model. For industrial uses the company manufactures a wide range of sizes, including two models of heavy-duty motor with ratings of 53 and 79 hp. respectively.

Worthington Pump & Mach. Corp. THE Worthington company entered the contracting field during the year with a kerosene-gasoline engine designed to operate concrete mixers and other types of equipment, such as diaphragm pumps and small plunger pumps. These engines are of the throttling governor type and are built in sizes from 2½ to 8 hp.

Air Compressors and Pneumatic Tools

IMPROVED control was a feature of compressor design in both stationary and portable types, particularly in respect to automatic unloading devices. A wider range of sizes and greater individual air capacities were offered in the mobile units, while one novel feature was the use of 8-in. pipe to serve the double purpose of forming the framework of a portable machine and at the same time acting as an air receiver. As was the case with other types of construction equipment, rubber-tired mountings for portable compressors showed an increasing use during the year. To serve an ever-widening field for pneumatic tools equipment has been developed for digging clay, calking pipe, tamping backfill, demolishing concrete masonry, scaling rock, and driving spikes. In addition, manufacturers have devoted considerable attention to improvements in the light, portable type of air hoists.

Chicago Pneumatic Tool Co. COMPRESSOR cylinder wear has been reduced by adding to the mixture of the casting a percentage of Mayari steel. During the year the company has perfected the control of its electric-driven compressors. Automatic equipment was developed for motor-driven compressors of the belted type, whereby, in addition to unloading the machine when the maximum pressure is reached, the design provides, depending upon the time required for unloading, for automatically stopping the motor, shutting off the oil supply, and then reaching normal speed before the machine cuts in again.

On the portable type of [illegible]essor rubber-tired trailer mounting[illegible] furnished. Operating speeds of these machines are controlled by an auto-pneumatic throttle which functions both in throttling down and speeding up.

For the company's line of pneumatic tools improved lubricating features have been developed and during the year an oil separator was introduced to prevent waste of oil through the discharge. With this device lubrication need be attended to only once a week as against daily without the separator.

Cement-Gun Co. AN INGENIOUS type of design was adopted for the Traylor portable gasoline-driven compressor by which the frame of the machine is formed of 8-in. pipe connected with a cast-steel head, the pipe serving both as an air receiver and a bearing frame. The air is inletted at one end of the pipe and discharged at the other, thereby insuring large receiver capacity and cooling area. This equipment is mounted on rubber-tired automobile wheels, springs and axles.

Ingersoll-Rand Co. GREATER individual air capacities and a better arrangement of sizes suitable for operating various groups of air tools were features of the year's development of the Ingersoll-Rand portable type compressors. A pneumatic clay digger was among the important air tool developments; it is, essentially, a pneumatic pick for both open trench and tunnel excavation. Applications of pneumatic hammers were made for calking lead wool and cast lead in pipe joints, for tamping backfill, and for demolishing concrete masonry. To facilitate the haulage of cars, skidding of timbers, and hoisting light steel a new line of double-drum hoists of the light portable type were put on the market.

Sullivan Machinery Co. OPERATION by belt from a tractor is provided for in a new type of Sullivan portable compressor mounted on a steel truck. The company's direct-flow angle-compound steam-driven compressor was introduced during the year. Its valves are under the control of the speed and pressure governors and the admission timing is regulated by speed and pressure factors. The exhaust valves may be set to suit local conditions of back pressure.

Pneumatic tool improvements included a pick hammer for drilling shallow bolt holes in rock or concrete, scaling rock, driving spikes, and other miscellaneous uses. The company's 16-lb. spader is equipped with both short and long shank tools for underground work or open trench. A non-rotating hammer drill, with long stroke and powerful blow, was developed for breaking pavements or concrete masonry.

Two types of portable air hoists were announced during the year, both single and double-drum. The double-drum type was designed for hauling scrapers in loading work at stock piles and in moving earth or other loose material. It is also applicable to derrick work.

The application of the Sullivan drill sharpening machine was extended to the making of stone channeling machine gang bits. Dies and dollies for this special work are now available.

Extra size diamond-drill core fittings were provided for deep oil-well tests in wild-catting and in production drilling.

Worthington *Pump & Mach. Corp.*

A SMALL vertical single-cylinder air compressor was put on the market during the year for contracting work by the Worthington corporation. It follows standard lines for equipment of this sort, except that the Laidlaw feather-valve used on the company's larger air compressors is installed on these small units. Consisting of a piece of ribbon steel, the valve weighs less than 1 oz. and, on account of its lightness, quietness and smooth operation are assured at high speeds.

(To be concluded)

Business Notes

AMERICAN ROLLING MILL CO., Middletown, Ohio, has engaged Dwight P. Robinson & Co., New York, for engineering and construction services on an extension to its plant at Ashland, Ky. The extension will include a jobbing and sheet mill, a galvanizing plant, and other work.

GENERAL ELECTRIC CO., Schenectady, N. Y., according to an announcement by G. E. Emmons, vice-president, has reorganized its general manufacturing department, effective Jan. 1. H. F. T. Erben, heretofore manager of the Schenectady works, has been named vice-chairman of the manufacturing committee and ranking member of the general manufacturing staff. Charles E. Eveleth succeeds to the position of works manager. J. A. Smith will continue as general superintendent.

NOEL PUMP & MANUFACTURING CO., of Orange Cove, Calif., has filed articles of incorporation with the county clerk at Fresno. The company is capitalized at $50,000. The directors are Carl F. Noel of Modesto, C. J. and W. J. Noel of Orange Cove.

S. W. LINDHEIMER, dealer in railway and contractors' equipment, Chicago, will sail for England this month to develop a large deal in railway track material.

EDWIN L. KING has been appointed, effective Jan. 1, district sales manager for the Reading Steel Castings Co., Inc., Bridgeport, Conn. His headquarters will be in Chicago and he will succeed M. L. Chase, resigned.

GEORGE MACNOE, manager of the Boston office of W. B. Connor, Inc., merchant-engineers, has been recalled to New York to take charge of the contractors sales department, handling heating and pumping equipment.

GIBB INSTRUMENT CO., Bay City, Mich., has taken over, under exclusive license, the manufacture and sale of the automatic and semi-automatic electric arc-welding machines developed, and heretofore manufactured by the Fred Pabst Co., of Milwaukee, and has contracted to act as selling agent for the Pabst line of patented covered electrodes. The Gibb company has announced its intention to cover the entire field of electric welding equipment.

Equipment and Materials

Ground Auger for Contractors

For the use of contractors in testing ground for foundations and for boring from street excavations under sidewalks and pavements for installing pipes or

wires by plumbing, electric and gas companies, the W. H. Anderson Tool & Supply Co., Detroit, has designed a special type of auger, shown in the accompanying illustration. The point is different from the usual nut auger and no lead screw or lips are used. The cutting edges are fish-tailed to permit of quick cutting and immediate release when pulling out to empty the earth accumulated in the screw.

The augers are built in diameters from 1¼ to 5 in. Augers 3 in. and less in diameter have the shank threaded to fit standard ¾-in. pipe couplings while those larger than 3 in. are threaded to fit standard 1-in. pipe couplings.

Auxiliary Cutter Increases Range of Trench Widths

A trench-excavator attachment, by means of which the cutting range of its excavators is increased without changing the buckets, has been perfected by the Buckeye Traction Ditcher Co., Findlay, Ohio. The rotary auxiliary cutter, as the device is called, makes it possible to cut, with one machine, trench widths which would formerly have required two different models. The device is intended to increase the variety of trench work on which the average contractor can afford to bid. With the new cutter the range of trench widths now possible with various Buckeye models is as follows: Model C-10, from 24 to 48 in.; C-15, from 24 to 60 in.; and C-20, from 40 to 76 in.

The device, as shown in the photograph, consists of cutting teeth mounted on two shafts, one on each side of the boom. As the shafts revolve these teeth dig into the trench side walls outside of the buckets, giving an extra cut on each side. The shaft supports are adjustable, permitting variation of cutting widths.

No additional power is required as the cutters take the load off the regular bucket side cutters. Power is transmitted by heavy steel roller chain operating from the shaft that drives the digging buckets. Four men, in two hours, it is stated, can attach or remove the auxiliary cutter. The new device has been used during the past year by the McHugh-Cole Co., contractors of Lima, Ohio. Their C-15 Buckeye excavator with the auxiliary cutter, has handled trenches from 30 to 60 in. in width.

Publications from the Construction Industry

Power Shovels—THEW SHOVEL CO., Lorain, Ohio, is distributing three new illustrated bulletins dealing with (1) its type A-1 steam shovel with 1-cu.yd. dipper, (2) all-steel semi-flexible type of continuous tread truck, and (3) proper methods of lubricating steam shovel machinery. The two bulletins first mentioned give details both in text and pictures of the shovel and tread. The third bulletin, on lubrication, contains a number of valuable suggestions as to the quality of lubricant best suited to various uses and its methods of employment. Gargoyle lubricants manufactured by the Vacuum Oil Co., New York, are recommended. Among the subjects covered in detail are the lubrication of steam valves and cylinders; gears, pinions and racks; gasoline engines; electric motors; bearings for steam, gasoline and electric shovels; wire rope and cable; and compressed-air operated shovels. Contractors will find in the lubrication bulletin information which should enable them to maintain their equipment in good condition and cut down on repair bills.

Mounted Crushers and Bins—SMITH ENGINEERING WORKS, Milwaukee, features its mounted gyratory rock breakers, screening plans and portable bins in a 15-p. illustrated bulletin explaining the use of this equipment in utilizing local materials for road building. The crushers are made in three sizes, the largest having an hourly capacity of 25 to 30 cu.yd. of 1½-in. stone.

Hydrants and Valves—MICHIGAN VALVE & FOUNDRY CO., Detroit, in an 11-p. illustrated pamphlet, presents cross-sectional drawings and brief descriptions of its fire hydrants and valves. One of the special features of the company's compression hydrant with frost case is a bronze extension piece containing the valve seat and drip which is bolted to the standard pipe of the hydrant and provides for universal adjustment of nozzle to any desired position with relation to the street. The entire standpipe, including all working parts, can be unscrewed from the shoe and lifted out through the frost case for inspection and repair. Other types of equipment dealt with are water gates, valve boxes, indicator posts, check valves, and sluice gates.

Business Side of Construction

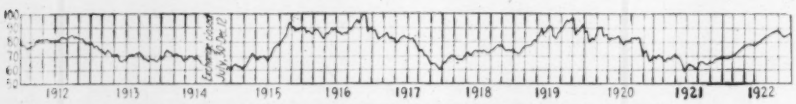
FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Trend of Stock Exchange Prices Upward

Combined Averages of Fifty Stocks, Half Industrials and Half Rails, Shown Over Ten Year Period

That the rise and fall in prices of securities in the stock market, constitutes a reliable barometer of future business conditions, is definitely pointed out by the Annalist *in its survey of the stock market of* 1922, *given in part, as follows:*

THE stock market of last year saw continually advancing prices for securities in what might be termed a bull market. It was, however, not a bull market in the general sense of that term. The demonstration was far less violent than that of the market of 1919, and it was probably influenced to a certain extent by investment demand, whereas the market of 1919 was one of the highest degree of speculative endeavor. The market of last year actually started in the latter half of 1921 and was a market that succeeded to a certain extent in predicting the future. It has often been said that the stock market acts as such an index and it is perfectly true that the stock market of 1922 was a barometer, and a correct barometer, to business conditions.



AVERAGE PRICES ON NEW YORK STOCK EXCHANGE

It was evident shortly after the turn into 1922 that business was improving and speculative buying of securities began in a moderate way until it was discovered that the floating supply of stock was not by any means large, that investment purchasing had been going along steadily, and that the foundation had been laid for an upturn of substantial proportions. The story of the year is perhaps best told in the market averages. The *New York Times* compilations show that the combined averages of fifty stocks, twenty-five industrials and twenty-five rails, touched a low point of 66.21 on Jan. 21, which was the low point of the year. The high point for that month was 70.27, and from then on the trend of prices was steadily forward. In September the averages touched a high of 90.23 and the low for that month was 84.49, a low that was practically on a par with the high point for July of 84.50. Stocks touched their highest point of the year on Oct. 18, when the averages reached a high of 93.06.

Aside from the business improvement, which the stock market was discounting, there was one other important development of the year, namely, the declaration of stock dividends, which provided a stimulus to stock market activities for many weeks. It was not quite clear why this rush to declare stock dividends should have been so favorably construed in Wall Street.

Financial Briefs

Bank Debits last week (ending Jan. 10) totaled $9,898,000,000, or $1,325,000,000 under the preceding week, when a large volume of year-end payments were shown.

Stock Dividends declared in 1922 aggregate $1,484,000,000, for 139 companies. More than a billion of this was distributed by units of the Standard Oil group.

English Securities issued in 1922 amounted to £584,951,000, against £392,800,000 in 1921 and £248,237,000 in 1913. Of last year's total, about 75 per cent were government loans, 3 per cent were municipals, and 22 per cent were for industrial and railway issues.

Bond market steady while a particularly heavy total of offerings ($200,000,000) was being absorbed New York Central $12,660,000 4½s equipment trust notes, to yield 5 per cent, were several times oversubscribed. Municipals active. Rails dull. Public utilities active and price trend slightly upward. Industrials quiet. Foreign securities strong.

Central Car Clearing Agency Proposed

Urging the establishment of a central clearing house agency for freight cars, S. Davies Warfield, President of the National Association of Owners of Railroad Securities, addressing a convention in Cincinnati, Jan. 12, gave the following reasons for the recurrence of car shortages:

"(1) That each carrier has not furnished, both as to class and amount, its quota of car equipment in proportion to the total requirements of transportation as a whole; (2) that every carrier has not secured as high efficiency out of the cars it operates as other carriers operating under like conditions; (3) that there has never been put in effect standardized plans under which freight cars shall be purchased, rehabilitated or rebuilt; (4) that methods are not practiced that will produce a better supply, more extended use and wider distribution of certain classes of interchange freight cars now in service or to be put in service; (5) that freight yard and terminal facilities are not used or being constructed such as will jointly operate quickly to handle and unload and return cars for reloading."

If the average load per car obtaining in 1920 and 1921 had been secured in 1922, it would have required 132,440 cars fewer in the first quarter of 1922 and 486,206, in the second, or an aggregate of 618,644 cars to handle the same relative amount of tonnage, according to the American Railway Association.

Steel Ingot Output Gained 73 per Cent in Year

Demand Keeping Prices Firm — Railroads Buying Heavily—Fuel, Pig Iron and Labor More Plentiful

Actual tonnage figures on steel ingot production, as reported by thirty companies which made 87½ per cent of the country's output in 1921, show a total of 29,116,453 tons during 1922, as against 16,826,946, for the preceding year.

With a gain of 73 per cent in production in one year, the present operating rate at 80 per cent of capacity and strong demand holding prices firm; an increased output is predicted for 1923, despite rumors of an impending coal strike.

The strength of the steel position is due largely to heavy bookings of tonnages for future delivery, as well as prospects of a sustained demand throughout the next quarter.

The railroads lead in the consumption of finished steel products; orders for steel cars at the present time representing the heaviest booked in the last seven years. Of the total output of finished steel during 1922, railroads consumed about 22 per cent and the construction industry about 15 per cent.

With a slight improvement in the labor situation since October, due to seasonal falling off of outdoor employment, and sufficient supplies of coal, coke and pig iron, the steel industry faces an active period as to orders and production; but as to price, the current quotation of $2 per 100 lb., Pittsburgh, on structural shapes, represents the price level prevailing at the beginning of the year 1916.

Steel ingot tonnages, by months, during the last two years are shown in the following table:

STEEL INGOT PRODUCTION IN GROSS TONS

Month	1921	1922
January	2,203,186	1,593,48[illegible]
February	1,749,477	1,745,02[illegible]
March	1,570,978	2,370,75[illegible]
April	1,213,958	2,444,51[illegible]
May	1,265,850	2,711,14[illegible]
June	1,003,406	2,634,47[illegible]
July	803,376	2,487,10[illegible]
August	1,138,071	2,214,58[illegible]
September	1,174,740	2,373,77[illegible]
October	1,616,810	2,872,41[illegible]
November	1,660,001	2,889,29[illegible]
December	1,427,093	2,779,89[illegible]
Total	16,826,946	29,116,45[illegible]

Large Contracts Let During Week

Among the week's announcements of contracts awarded in Construction News, pp. 29 to 42, are the following large projects:

Office building, Los Angeles, Calif., to MacDonald and Kahn, $1,500,000.

Theatre and office building, Milwaukee, Wis., to M. Tullgren & Sons Co., $1,500,000.

Apartment, New York, N. Y., $1,000,000. Work will be done by separate contracts under supervision of architects, Gronenberg and Leuchtag.

Gain in December Bond Sales

Long-term municipal bond sales during December totaled $55,927,980, for the entire country, representing an increase of $14,063,817 over the preceding month, according to the *Commercial and Financial Chronicle*. The total for the entire year 1922, however, reached $1,040,186,612, as compared with $1,208,768,274, for the whole of 1921, a decrease of nearly 14 per cent.

Short-term securities issued during December, amounted to $35,126,155, of which $29,050,000 were issued by New York City.

Sales of long-term securities in Canada totaled $21,020,784, during the month. The Province of Ontario issued $15,000,000 of this total, and the Ontario Hydro-Electric Commission, $3,000,000.

Among the more important issues of the month were: State of Missouri, $5,000,000 4½s at 99.56, a basis of about 4.73 per cent; South Dakota, $3,000,000 4¾s at 100.91, a basis of about 4.70 per cent; New Jersey, $2,000,000 4¼s at 102.097, a basis of about 4.06 per cent; Memphis, Tenn., $1,452,000 4¾s and $1,509,000 5s at 100.19, a basis of about 4.86 per cent; Allegheny County, Pa., $2,250,000 4¼s at 101.87, a basis of about 4.10 per cent; Cleveland, Ohio, $2,000,000 4½s at 100.66, a basis of about 4.43 per cent; Richmond, Va., $2,000,000 4½s at 102.242, a basis of about 4.37 per cent; Hartford, Conn., $1,500,000 4s at 100.669, a basis of about 3.94 per cent; St. Louis County, Mo., $1,000,000 4½s at 98.81, a basis of about 4.63 per cent and Government of the Philippines, $13,000,000 4½s at 95.07, a basis of about 4.79 per cent.

Of the thirty-six representative issues listed in the accompanying table, eight sold at par, twenty-three, above and five, below part; the yields ranging from 4.06 to 5.92 per cent.

Rates varied from 4 to 6 per cent. New England issues all drew 4 per cent. The 6 per cent disposals were all located in the Southern and Western states. Western bonds, that is to say those in the far Western states, observed a minimum rate of 5 per cent. Those drawing from 4½ to 5 per cent were fairly well distributed throughout the country, especially in the Middle Atlantic and Middle Western groups and the states immediately west of the Mississippi River.

Bids Wanted on Big Jobs

Among the projects on which bids are either asked or will soon be called for, in Construction News, pp. 29 to 42, are the following:

About 203 mi. of highways, Ontario, Canada, for Province of Ontario $3,000,000.

Hotel, Philadelphia, Pa., for Philadelphia Hotel Co., $3,000,000.

Loft, Philadelphia, Pa., Hoffman-Henon Co., architects, $2,000,000.

Office building, Memphis, Tenn., for Security Building Co., $1,000,000.

Lodge and office building, Harrisburgh, Pa., for International Brotherhood Compensation and Relief Fund, Inc., $1,000,000.

High School, Boston, Mass., for Schoolhouse Commission, $1,000,000.

School of Medicine, Denver, Col., for Regents of University of Colorado, $1,250,000.

Art Museum, Marion, Pa., for A. Barnes, $3,000,000.

Sewer, Milwaukee, Wis., for Sewerage Commission, $900,000.

Grading, surfacing, etc., Bismark, N. D., for State Highway Dept., $1,000,000.

REPRESENTATIVE PUBLIC BOND SALES DURING DECEMBER, 1922

State	Purpose	Amount	Rate Per Cent	Sold For	Basis	Maturity	Dated	Purchased By
Missouri	Road	$5,000,000	4½	99.56	4.73	.....	Dec. 5, 1922	Kuhn, Loeb & Co., of New York and others.
New Jersey	Road	2,000,000	4¼	102.097	4.06	1923–53	Dec. 9, 1922	Dillon, Read & Co., of New York and others.
County								
Daviess, Ind	Road	20,800	5	101.17	4.77	1924–33	Dec. 15, 1922	Fletcher Savings & Trust Co., Indianapolis.
Humphreys, Miss	Road	100,000	6	105.07	5.50	1923–47	Dec. 15, 1922	Liberty Central Bank of St. Louis.
Montgomery, Ohio	Road improvement	93,000	5½	102.325	5.05	1924–32	Aug. 15, 1922	A. C. Allyn & Co., of Chicago.
Summit, Ohio	Road improvement	392,000	5	101.07	4.79	1924–32	Jan. 1, 1923	Ohio State Bank & Trust Co., of Akron.
Vanderburg, Ind	Road	8,700	4½	100	....	1924–33	Dec. 26, 1922	West Side Bank of Evansville.
Wayne, Ohio	Improvement	100,000	5½	102.066	....	1923–31	Sept. 15, 1922	Prudden & Co., of Toledo.
Township								
Belle Valley School Dist., Noble Co., Ohio	School building	75,000	5½	105.01	4.93	1924–44	Aug. 1, 1922	L. R. Bollinger & Co., Cincinnati.
Chicago Sanitary Dist., Cook Co., Ill	Sanitary improvements	3,000,000	4	98.0792	4.22	1925–43	Jan. 1, 1923	First Trust and Savings Bank and others, of Chicago.
Hadden Heights, School Dist., Camden Co., N. J	School building	287,000	5	104.763	4.64	1924–61	Dec. 1, 1922	Haddon Heights National Bank.
Lakewood Ocean Co., N. J	Road improvement	195,000	5	100.	....	1926	July 15, 1922	R. M. Grant & Co., New York City.
Lebanon School Dist., Lebanon Co., Pa	High School Annex	110,000	4¼	102.02	4.11	1933–53	Jan. 1, 1923	Janney & Co., of Philadelphia.
Liberty School Dist., Allegheny Co., Pa	School building	27,000	4½	101.58	4.36	1925–51	Jan. 1, 1923	Redmond & Co., of Pittsburgh.
Livonia Common School Dist., No. 10, Livingston Co., N. Y.	School building	10,000	5	102.15	4.54	1924–33	Jan. 1, 1923	Myron Green, of Rochester.
Memphis Independent School Dist., Hall Co., Tex	School building	110,000	5½	102.31	....	1924–63	Dec. 21, 1922	Stern Bros. & Co., of Kansas City.
Middle Fork Irrigation Dist., Hood River Co., Ore	Ditch	75,000	6	98.78	....	1928–53	Jan. 1, 1923	Ralph Schneelock Co., of Portland
Oyster Bay Union Free School Dist. No. 21, Nassau Co., N. Y	School building	75,000	4½	100.	....	1927–56	Dec. 1, 1922	Sherwood and Merrifield of New York.
Municipality								
Bedford, Ohio	Street improvement	10,958						
	Road improvement	16,582	5½	101.24	5.26	1924–32	Dec. 1, 1922	Seasongood and Mayer, of Cincinnati.
	Water	4,140						
Coeymans, N. Y	Bridge	20,000	5	100	....	.....	.....	First National Bank of Coeymans.
Elgin, Kans	Paving	50,000	5	100	....	1942	June 1, 1922	Brown-Crummer Co., of Wichita.
Endicott, N. Y	Sewer	35,000	4½	101.169	4.36	1923–42	Jan. 1, 1923	Farson & Son, New York City.
	Paving	30,000	4½	100.736	4.38	1923–37		
Hackensack, N. J	Sewer	490,000	4½	102.22	4.33	1924–61	Jan. 1, 1923	Eldredge & Co., New York City.
Haddon Heights, N. J	Street and drainage	8,000	5	100.	....	1925–40	Feb. 1, 1923	Haddon Heights National Bank.
	Sewer improvement	23,000	5	100.	....	1925–62		
Hysham, Mont	Sewer	5,000	6	100.	....	.....	Dec. 26, 1922	Bankers' Trust Co., of Denver.
Jenera, Ohio	Street improvement	4,000	6	100.2875	5.92	1924–28	Oct. 1, 1922	Farmers Bank Co., of Jenera.
Laramie, Wyo	Sewer	162,000	5	100.63	....	1943	Dec. 30, 1922	Beuwell, Phillips & Co., of Denver Harris Trust and Savings Bank of Chicago.
Manchester, N. H	School	300,000	4	98.11	4.23	1923–32	Dec. 1, 1922	E. H. Rollins & Sons, of Boston.
Sioux City, Ia	School	55,000	5	103.45	....	1925–32	Jan. 1, 1923	Geo. M. Bechtel & Co., of Davenport.
Port Huron, Mich	Paving	114,000	5	101.90	....	1923–33	Dec. 1 1922	Nicol, Ford & Co., of Detroit.
	Sewer	25,995	5	101.90	....	1923–33		
	Sidewalk	14,100	5	101.90	....	1923–25		
	Curb	1,696	5	101.90	....	1923–25		
Princeton, N. J	Sewer	50,000	4½	100.95	4.30	1924–33	Jan. 1, 1923	Princeton Bank & Trust Co.
Unatilla, Fla	Street	40,000	6	100.60	....	1933–53	Jan. 1, 1923	Hanchett Bond Co., of Chicago.
	Water and sewer	15,000						
Wallowa Valley Improvement Dist., No. 1, Ore	Improvement	5,000	6	100	....	1938–42	Jan. 1, 1922	Ben Johnson, Enterprise, Ore.
Walton, N. Y	Highway	16,000	4.7	100.35	4.65	Yearly	Dec. 1, 1922	Geo. B. Gibbons & Co., Inc., of New York.
Winona, Kan	Water	34,000	5½	102.86	....	.....	Dec. 1, 1922	Guarantee Title & Trust Co., of Wichita.
Winnipeg, Manitoba, Canada	Schools	600,000						
	Hydro-electric system	300,000	5	96.959	....	1943	Jan. 2, 1923	A. E. Ames & Co., of Toronto; the Old Colony Trust Co. and Parkinson & Burr, of Boston.
	Local improvement	300,000						

Cement Shipments Break Record

A total of 116,563,000 bbl. of cement were shipped to consumers throughout the United States during 1922, according to latest statistics issued by the Geological Survey. This represents the heaviest total of shipments recorded in the history of the industry. Shipments during 1921 reached 95,051,000 bbl. or a little over three-quarters of the total for the year just passed.

The total output for the year reached 113,870,000 bbl. as compared with 98,293,000, during 1921, a gain of 15 per cent in production.

CEMENT PRODUCTION SHIPMENTS AND STOCKS.

	1921 No. of bbl.	1922 No. of bbl.
Production	98,293,000	113,870,000
Shipments	95,051,000	116,563,000
Stocks on hand at end of year	11,938,000	9,134,000

Stocks of finished Portland cement at factories, Dec. 31, 1922, amounted to 9,134,000 bbl., or 2,804,000, under the quantity on hand one year ago.

There were also about 2,823,000 bbl. of clinker, or unground cement, at the mills at the end of December, as against 1,949,000 bbl. at the beginning of the month.

As shown in the accompanying table, stocks on hand Dec. 31, 1922, were not only lower than those available Dec. 31, 1921, but shipments exceeded production by nearly 3,000,000 barrels.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of January 4; the next, on February 1.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb	$3.14	$3.95	$4.40	$3.02½	$3.15	$3.85	$3.25	$3.70	$3.50
Structural rivets, 100 lb	3.85	4.60	5.25	3.75	4.00	4.80	4.75	4.25	6.00
Reinforcing bars, ¾ in. up, 100 lb	3.04	3.85	3.15	2.92½	3.05	3.62½	3.35	3.70	3.25
Steel pipe, black, 2½ to 6 in. lap, discount	54%	52.50%	45%	59½%	57-5%	41%	39.2@51.8%	40%	22.50
Cast-iron pipe, 6 in. and over, ton	+55.50	47.82	—57.00	—51.20	56.16	65.61	55.00	55.00	55.00
Concreting Material:									
Cement without bags, bbl	2.60@2.70	2.54	2.25	2.05	2.29	2.85	2.71	2.90	2.88
Gravel, ¾ in., cu.yd	2.00	1.75	2.25	2.25	1.75	1.90	2.15	1.00	1.50
Sand, cu.yd	1.00	1.32	1.87½	2.25	1.00	1.00	1.50	1.00	1.25
Crushed stone, ¾ in., cu.yd	1.75	2.00	+1.80	2.25	2.25	3.50	2.15	3.00	1.90
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	59.00	36.00	50.00	52.00	42.75	+51.50	35.00	25.00	90.00
Lime, finishing, hydrated, ton	16.80@ 17.10	23.00	22.50	18.00	25.50	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	2.75@ 3.13½	1.85	2.50	1.40	1.40	2.70	1.75	2.80	11.00
Common brick, delivered, 1,000	23.50	10.60	—10.85	11.00	18@19	12.00	15.50	14.00	16.00
Hollow building tile, 4x12x12, per block	Not used	.0859	.115	....	.0836	.065	....	.11	.115
Hollow partition tile 4x12x12, per block	.1230	.0859	.115	.0674	....	.065	.108	.11	....
Linseed oil, raw, 5 bbl. lots, gal	+.93	+1.00	—1.07	.98	1.01	—1.10	1.04	.86	1.02
Common Labor:									
Common labor, union, hour	.60	.35	.30@.50	.....	.....	.50@.55	.56¼	50@.60	.....
Common labor, non-union, hour	.45@.60	.30	.30@.50	.72½	.35@.50	.35@.50	.50	....	.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Cement and concrete laborers' rate, 81½c.; pick and shovel men, 60c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.55 for Kelly Island and $1.45 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on Douglas fir instead of pine. Sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 99.13). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½-in., $22.50; 6-in., $108.

Changes Since Last Week

Continued heavy demand for finished steel, particularly railway materials, responsible for present firmness in prices. Quotations of $2 per 100 lb. on steel bars giving way to somewhat frequent quotations of $2.10@$2.15, f.o.b. Pittsburgh. Bars showing especially heavy demand; mills sold through first quarter, and considerably well booked for second quarter deliveries. Shapes unusually firm for this season of the year; quoted at $2 per 100 lb., f.o.b. mill. Quotations under $2, on steel plates, no longer appearing in the market; mills rapidly filling up on orders, principally for car materials.

Lumber market firm, especially as to yellow pine. Mill stocks of pine are sufficient to meet demand; dealers' yards, however, are not heavily stocked. Existing prices are unusually steady for this season of the year. Douglas fir, however, advanced $1 per M.ft. b. m. in Denver, during week. A total of 361 mills reporting to the National Lumber Manufacturers' Association for the week ending Jan. 6, show 643,763,469 ft. cut; 804,854,584 ft. shipped and orders for 785,211,989 ft. b. m. This represents a drop, in one week, of nearly 9 per cent in production; 3 per cent in shipments and 4 per cent in orders.

The National Lumber Trade Barometer, Jan. 12, 1923, shows the position of the industry at 30 per cent below normal as to output; 20 per cent below, on orders and 12½ per cent below, in shipments. Despite recent quietude of linseed oil market, price fluctuations are reported in four principal cities reporting weekly to *Engineering News-Record*. New York quotes advance of 3c. and Atlanta, 5c. per gal; while declines of 2c. are reported in Dallas and 3c. per gal. in Denver, since last week. Red and white lead, both dry and in oil, rose ½c. per lb. during week, making the second advance since December.